POWER

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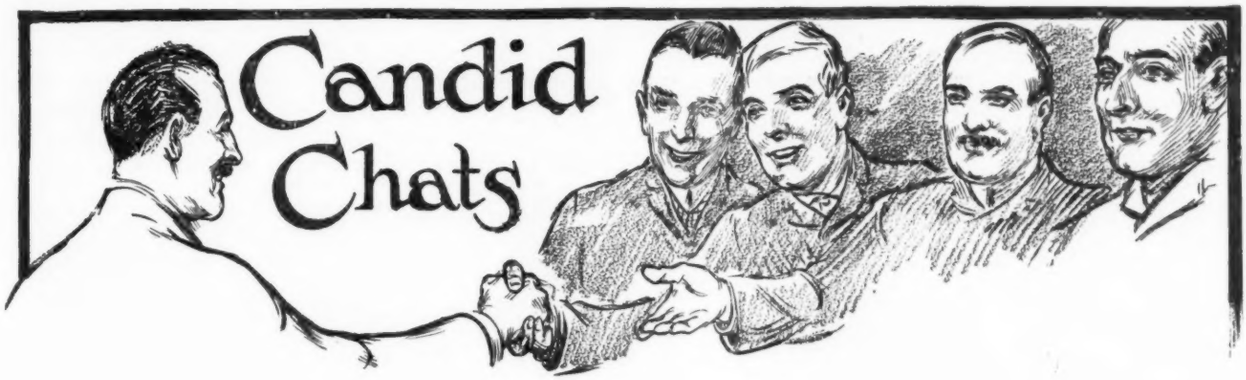


A Heart-to-Heart Talk from the New Chief

I HAVE asked you all to stand by for a few moments this morning, boys, so that I can shake hands with each one of you as I take up my work as the new chief of this plant. It is a pleasure to me to look forward to working with you under Mr. Brown's management, and I want every man here to feel that I am his friend and will do my best possible to give him a square deal at all times. In return I ask that you treat me in the same way. It was my good fortune to know something of your work through your former chief, Mr. Johnson, and I believe that I shall receive the same loyal support that you gave to him for so long.

"This is the largest and most important station I have ever had charge of, and I shall doubtless make mistakes in my new work. I ask you to be patient if things do not go just as you have been used to seeing them and to feel free to come to me at any time with suggestions. Do not feel hurt if I find myself unable to accept some of these. I am responsible to Mr. Brown for the plant and its service. I will bear the blame for mistakes and omissions charged to my door; and as a matter of fact, boys, whatever you do will affect our standing together with the powers above us. Unless we can all feel free to speak our minds frankly to each other, accepting both praise and blame for what they are worth and no more, we will be sure to regret it. Every one of us, I suppose, hopes to advance in his work to higher and better positions; not one of us but can learn something constantly from another, and we shall make progress and be contented together just so far as we bring the spirit of team-play to bear upon our daily and nightly toil. We are all hired to do our best to run this plant at the lowest cost per kilowatt-hour that matches up with A-1 service, and if I am not mistaken, we are going to give the plant of the South End Manufacturing Company over there in the valley some pretty close competition on costs. Anyhow, we must not forget that the best good of our plant is always to be our first thought, and our own advancement should not be so constantly on our minds as to hide our duties from us.

"I am glad that as every day passes I shall know each one of you better than I can this morning. Some of the equipment in this station is new to me, so far as handling it goes, and I know you can tell me a lot about how it behaves. I am here to learn as well as anybody else. Do not hesitate to tell me just what you think if you see the machinery being run differently from what you have been used to; but as I said before, don't get 'peeved' if I sometimes prove to be "from Missouri." If you recommend handling a pump or a stoker in a certain way and I don't fall in with the idea, and if we have trouble with the equipment as a result, it will be up to me to explain my decision to the Big Boss Upstairs. Every man must have his own ideas or only be a rubber-stamp engineer, and so I want you all to realize that I will take the entire responsibility for my decisions. But just as Mr. Brown holds me responsible, so I shall hold you responsible within your own jobs for results. So far as I can I shall leave methods to you watch and boiler-room engineers and shall look mainly for results.

"Mr. Brown has asked me to do everything I can to keep down the cost of power per kilowatt-hour in this station; in fact, he frankly told the Public Service Commission at a hearing last month that he was going to try to find a chief who could realize some of the opportunities for economy this equipment now offers with the help of you men right here in the station. Now, boys, I am a great believer in recording instruments, and I expect we shall have quite a number of these around the plant soon, and that I shall be sitting up nights before long puzzling over charts and log sheets and trying to go into operations here with a fine-toothed comb. I don't want you boys to feel that these instruments are being put in to make your work harder or to give Mr. Brown and myself 'dope' by which we can find fault with you. That isn't the idea at all. We are going to put in such stuff as recording steam and temperature gages, steam-flow meters, and so on, simply to try to learn where we are losing heat and to teach us how better to make the most of our plant. I believe that we must get into the way of looking at our station operation as though it were a continuous test; that every one of us can learn something from these instruments and thus become more valuable to our employer and better fitted to take up our future work, wherever it may lie.

"That is about all I want to say now, boys, except that our success depends upon the faithfulness to duty of each one and that every man here will have an equal chance, to the best of my ability. In a sense we are all making a fresh start today, and if we make good, I know that we shall reap the reward. My middle name is 'Welcome,' and I hope and believe that we shall make a name for ourselves and this plant and be glad that we were privileged to work together from this day forth."

From H. S. KNOWLTON, 136 *Lexington Ave., Cambridge, Mass.*

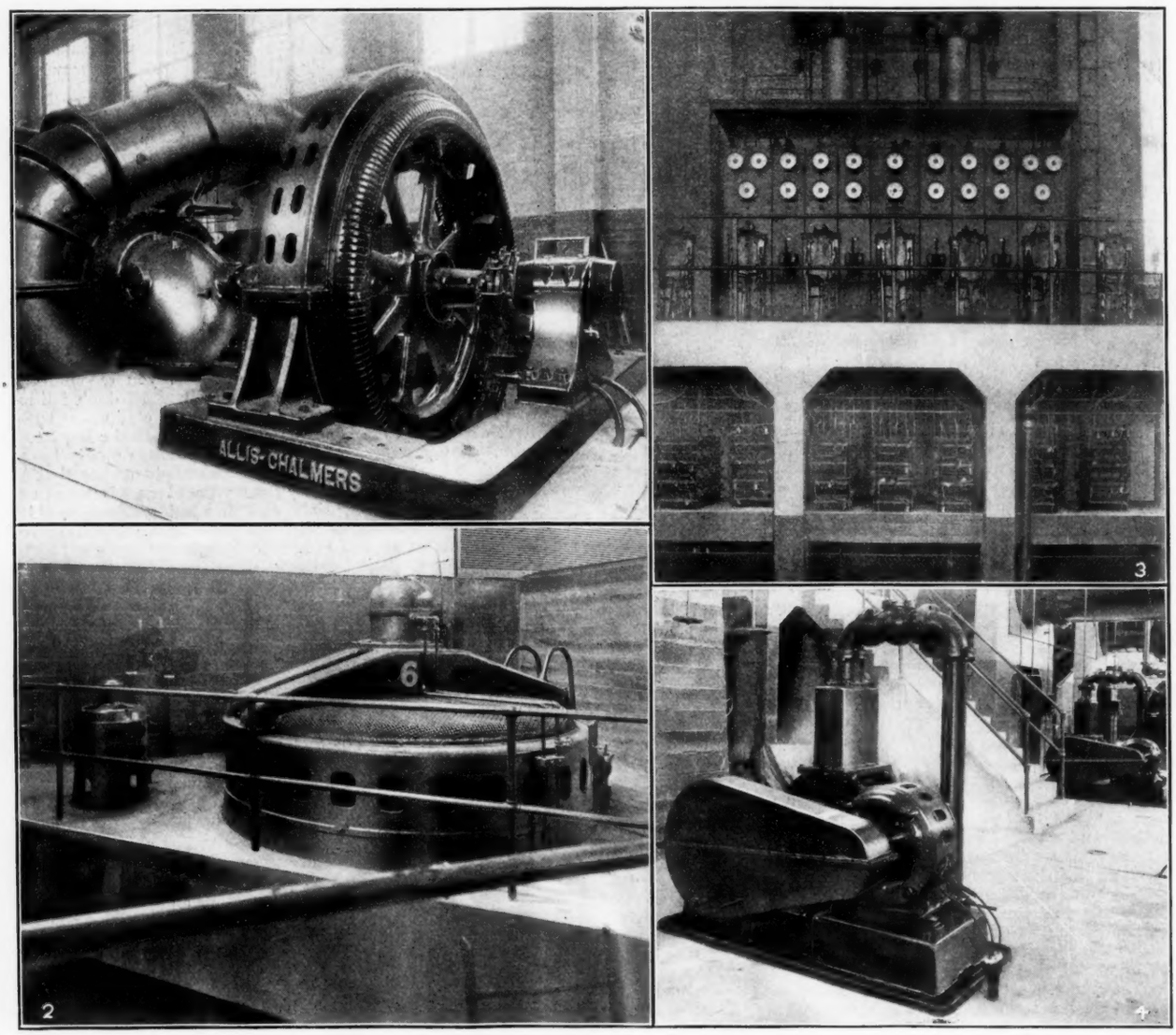
North Memphis Pumping Station

By T. M. Heermans

SYNOPSIS—Equipment consists of four 72-in. horizontal centrifugal pumps driven by 750-hp. induction motors having combined capacity to lift over levee wall 1,200 cu.ft. of water per second and two 36-in. vertical drainage pumps with thrust bearings on top. Special vacuum-breaking devices are installed.

The North Memphis Levee pumping station, which is part of the city's new flood-prevention project, was put into operation the early part of the present year and has since shown that the large pumping units in the station will be effective in handling flood conditions. The four main pumps which the station contains will discharge together 1,200 cu.ft. of water per second over the levee wall. This quantity would make a stream about 40 ft. wide and 10 ft. deep flowing 3 ft. a second, and is probably more water than is discharged by horizontal direct-connected motor-driven centrifugal pumps in any other station in the United States. For this reason a description of the pumping machinery may be of interest.

Partly above and partly below ground the pumping station was built over the Bayou Gayoso, which flows through the lower half of the building into the Wolf River, which in turn empties into the Mississippi. The waterway through the station is usually open, but can be closed by sluice gates so that when a flood appears in the Mississippi River the water is prevented from backing up through the station, and the water in the bayou is lifted over the levee wall by the large pumps and discharged into the Wolf River.



FIGS. 1 TO 4. VIEWS OF THE MEMPHIS PUMPING STATION

Fig. 1—One of the 72-in. storm pumps. Fig. 2—One of the vertical motors driving 36-in. drainage pump. Fig. 3—Switchboard, motor starters and resistances. Fig. 4—Vacuum pumps used for priming

The pumping equipment consists of four storm units, which are 72-in. horizontal centrifugal pumps directly

connected to 750-hp. induction motors, two 36-in. vertical drainage pumps connected to 300-hp. vertical induction motors, the suction and discharge piping, the vacuum priming system and the switchboard and motor-control equipment. In addition to the purely pumping equipment the station has a 20-ton motor-hoist crane and the sluice gates already mentioned.

The pumps, motors, switchboard, motor control and wiring were designed, furnished and erected by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis. The plate-steel suction and discharge piping was supplied by the Southern Boiler and Tank Works, Memphis, Tenn. The station was built and the machinery furnished and installed under the supervision of J. H. Weatherford, city engineer.

The main, or storm, pumps are of the horizontal double-suction centrifugal type with horizontally divided casings. The water is drawn up into the pump runner from both sides through plate-steel suction pipes that extend vertically downward into the suction chamber. These suction pipes are bolted to the elbows, which are part of the pump covers. The pump discharge opening extends upward at an angle, and the nozzle that connects to the discharge pipe is 72 in. diameter. The discharge pipes from the pumps, which are of plate steel, extend across the station and out through the side wall, where they bend down and end with a cast-iron foundation ring that supports the outer end of the pipe and makes the discharge opening into the discharge canal.

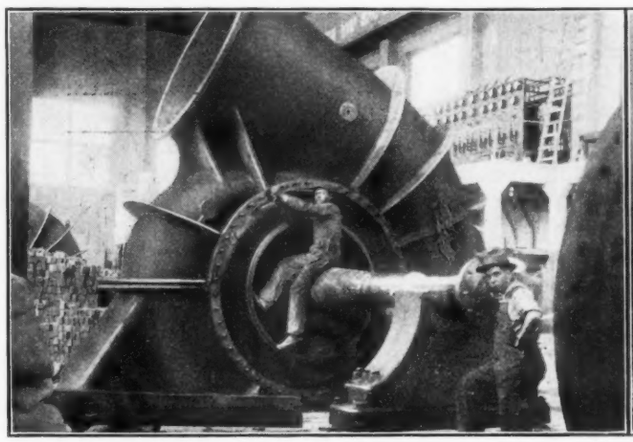


FIG. 5. ONE OF 72-IN. STORM PUMPS UNDER ERECTION

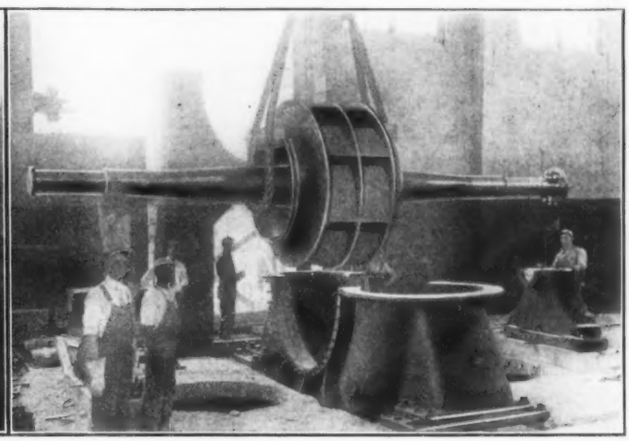


FIG. 6. RUNNER OF 72-IN. PUMP BEING LOWERED INTO PLACE

Each of these pumps is directly connected to 750-hp. 3-phase 60-cycle 6,250-volt wound-rotor induction motors that operate at a full-load speed of about 115 r.p.m. At this speed each pump discharges 300 cu.ft. per sec. against a total head of 15 ft. The overall length of the pump and motor is 35½ ft., the height of the pump 15 ft. above the floor, and the weight of one pump with motor 90 tons. It is not necessary to operate these large pumps frequently, as they are only required during periods of heavy rains.

There are two 36-in. pumps for handling the sanitary sewage of the city, which is diverted to the station when the river stage is above 34-ft. gage. These pumps are of the vertical single-suction centrifugal type and are located at one end of the station and at a lower level than the main pumps, so that ordinarily the water flows up into these pumps and they do not have to be primed. Priming piping is provided, however, to one 36-in. pump, so that it can be started when the water is at a low level in the bayou. The discharge is through cast-iron pipe and check valves into the discharge basin.

Each of these pumps will deliver 80 cu.ft. per sec. against a total head of 22 ft. They are directly connected to vertical motors located on the main floor of the station 20 ft. above the center line of the pumps. The motors are of the 3-phase 60-cycle 6,250-volt wound-rotor type rated at 300 hp. and operated at a full-load speed of about 172 r.p.m. They have a specially designed bridge of heavy construction across the top, which supports a disk-type vertical thrust bearing. The latter carries the entire weight of all the rotating parts of both the motor and the pump and the unbalanced water pressure on the pump runner.

This arrangement of the thrust bearing on top is a notable feature of these units. The connection between the motor and the pump shaft is made by a flanged coupling, the flanges being forged solid on the ends of the shafts. The vertical shaft bearings are the top and bottom motor bearings and a bearing in the top cover of the pump, together with the vertical thrust bearing on top of the motor. In a vertical unit of any kind the thrust bearing is important, and by placing it at the top end of the shaft it is located in the most accessible and easily observed place. It is also best situated mechanically to carry the rotating parts. By making the shaft connection solid and providing one large thrust bearing, two thrust bearings are avoided, this arrangement being much used with vertical water turbines. The vertical units are operated more often and for longer periods than the horizontal pumps.

Power is brought in over two separate lines, each equal to the capacity of the station. The switchboard consists of the two incoming line panels, six motor panels and a busbar tie panel. It is placed in the center of the station near one side wall on a gallery above the station floor. The motor starters are placed on this same gallery in front of the switchboard with the starting resistances located under the gallery below the starters and out of the way. When starting up the units the operator can plainly see all the motors from the gallery, and the switches and controllers are conveniently located close at hand. The controllers are of the drum type, and each is mechanically interlocked with the primary

oil switch of the motor that it starts, so that the oil switch cannot be closed until the starting handle of the controller has been returned to the "off position." As an additional safeguard there is an extra controller of sufficient capacity to start any motor, which is wired so that it can be connected to any of the motors as required.

As the main pumps are set above the level of the water in the suction chamber, they must be filled with water before pumping can commence. A vacuum priming system has been provided for this purpose, which consists of two vacuum pumps suitably connected to the main pumps and discharge piping. The vacuum pumps are of the rotary high-vacuum type, chain driven by 20-hp. induction

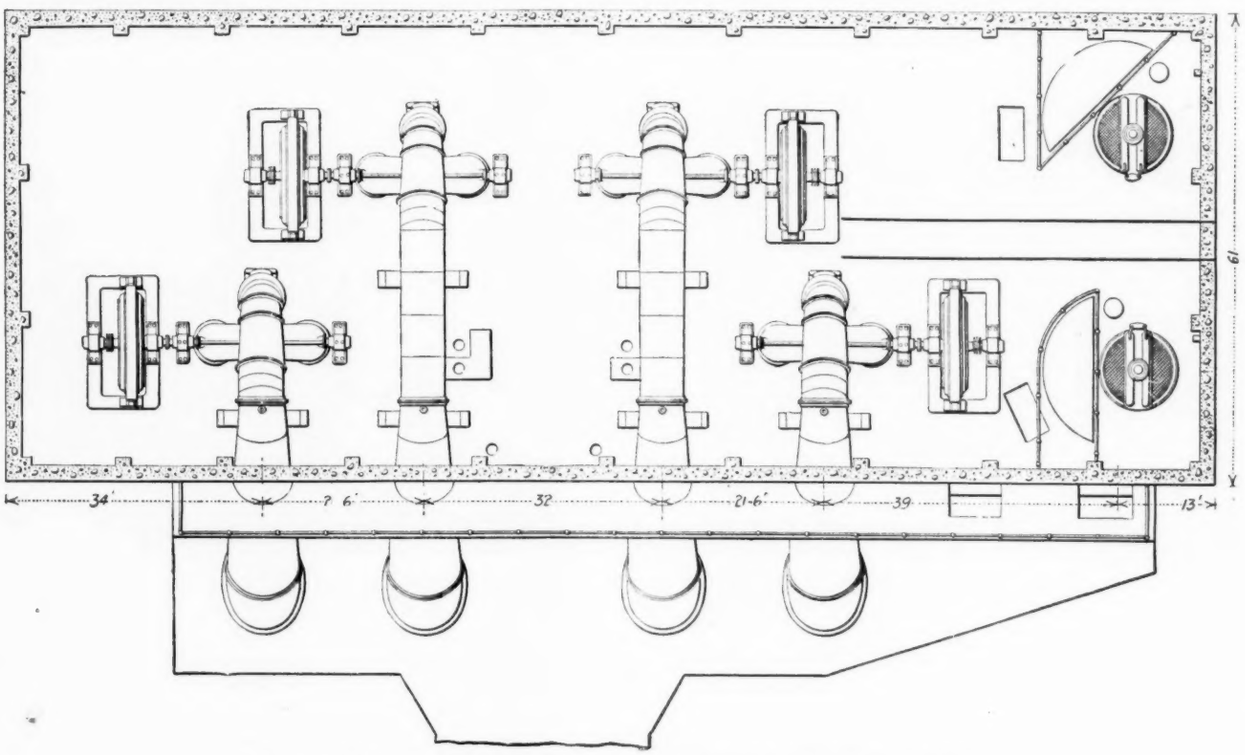


FIG. 7. PLAN VIEW OF NORTH MEMPHIS LEVEE PUMPING STATION

motors mounted on the extended sub-bases of the vacuum pumps. Each vacuum pump at a speed of 250 r.p.m. will displace 400 cu.ft. of air per min. and is suitable for operating against a suction of 22½ ft. The large pumps are started up empty and primed while running. To get full load on one unit—that is, to prime one pump—requires from six to ten minutes' operation of both vacuum pumps.

Other pumping equipment in the station consists of two vertical sump pumps and special vacuum-breaking devices on the main-pump discharge pipes. The sump pumps are 6-in. vertical centrifugals used to drain the vertical pump pit and the suction basin.

A feature is the vacuum-breaking devices which, so far as the writer knows, were applied for the first time in this station to do the work required. They are used to prevent the water from flowing back and flooding the city should the voltage fail and the motors stop. In such a contingency the pumps would cease to operate and the water from the Wolf River would tend to siphon back through the discharge pipe, pump and suction pipes into the bayou, if the vacuum at the high point of the discharge pipes were not broken. To break the vacuum, a valve is placed in the discharge pipe from each pump and is held shut by a rod fastened to a lever connected to the valve stem, the rod being connected at its lower end to a tripping device. A catch on the shaft of the tripping weight engages with a collar on the rod and holds the rod down when the tripping weight is held in position by a magnet energized by the current operating the motor. When the voltage fails, the magnet releases the tripping weight, unlatching the rod and allowing the valve to be opened by the vacuum supplemented by a spring.

Although this pumping station has been in operation only since the first of the year, the following extracts from the Memphis papers will show that it does the work for which it was designed:

Though the Mississippi River gage stood at near 38 ft. the Bayou Gayoso was about as dry as it formerly was in low water.

With the gage at 38 ft. the bayou in former years has been lapping over its banks in places. But the North Memphis pumps and the two interceptors in the south end have eliminated all possibility of another Memphis overflow.

After a 24-hr. run ended at 8 o'clock yesterday morning one of the 36-in. pumps had drained the bayou. This afternoon one of the 72-in. pumps will be put to work lifting the bayou water over the North Memphis Levee wall.

The big pumps at the North Memphis pumping station demonstrated for the first time their effectiveness by bringing the stage of the water against the levee, following heavy rains, to the same point which was registered when the pumps began working prior to the downpour.

By working the 36-in. pump for 24 hr. and two 72-in. pumps for a total of 6 hr. and 25 min. the engineers managed to pump away 1.75 in. of rainfall, amounting to 13,500,000 cu.ft., or 101,000,000 gal. of water. The entire rainfall of 1.75 in. fell in 10 hr., beginning at 10 a.m., at least 1 in. of it falling in 3 hr. This gave the engineers a splendid opportunity to test the efficiency of the pumps.

The pumping station was built and the machinery furnished and installed at a total cost of approximately $75,000.

Research Work for the Operating Engineer--Heating Problems

By Charles L. Hubbard

SYNOPSIS—A suggestion that operating engineers engage in systematic research work for the benefit of science, supplementing the work of experimental laboratories, since much of the work of the latter is unsatisfactory because it is limited to such small samples and fractional calculations. Special attention is given to heating problems.

The ultimate object of laboratory research work in various lines of engineering is its application to everyday needs. While precision in making tests under ideal conditions is desirable and necessary, often the ordinary plant, operating in a normal way, offers a better opportunity for valuable research work than the most finely equipped laboratory. Results obtained under ideal conditions must usually be modified to suit actual working requirements and in many instances must be supplemented by a certain amount of judgment based on observation. Without in any way detracting from the importance of laboratory work, it seems reasonable to suppose that many of the practical data, at present roughly estimated, may be more accurately obtained by the operating engineer through systematic observation in the plant than in the best-equipped laboratory. Again, the operating engineer has an advantage over the consulting mechanical engineer, because he is not limited as to time, and his observations may extend through the year or longer if necessary. These tests carried out in actual working practice would naturally have more value than tests made under ideal conditions and then "corrected" for actual conditions.

Data Available to Engineer

The following outline is given of matters relating to combined power and heating work in which the operating engineer has an opportunity of obtaining valuable data, which at present are available only in crude form or based upon approximation or deducted from laboratory experiments, that do not give the desired information in practical form. It is not the intention to replace, but rather to supplement, the data already available.

The items to be mentioned are some that have suggested themselves from time to time in the writer's special line of work, and may be added to by others whose requirements are different.

Someone may ask why he should take the trouble and possible expense, as he receives no remuneration. The following suggestions, however, may find favor with men who are desirous of contributing something to engineering without the expectation of immediate returns. Incidentally, by taking up such work, they will add to their own value, as engineers, for the experience obtained will be of much assistance and may lead to greater efficiency in their own plant.

The specific data sought will be of use in determining the benefit of combining power and heating in the same plant, which is a matter of vital importance to the operating engineer.

One point upon which there is need of more definite information is the weight of steam actually used in a given building, under varying outside temperatures, as compared with the theoretical requirements, showing how much the actual requirements exceed the theoretical, to give a measure of the waste. This alone may lead to methods of regulation that will bring about a substantial saving in operation and should be sufficient to persuade the owners of the building to furnish the small amount of equipment needed for making the tests.

For example, radiating surface is usually designed for 70 deg. in zero weather, but for estimating the weight of

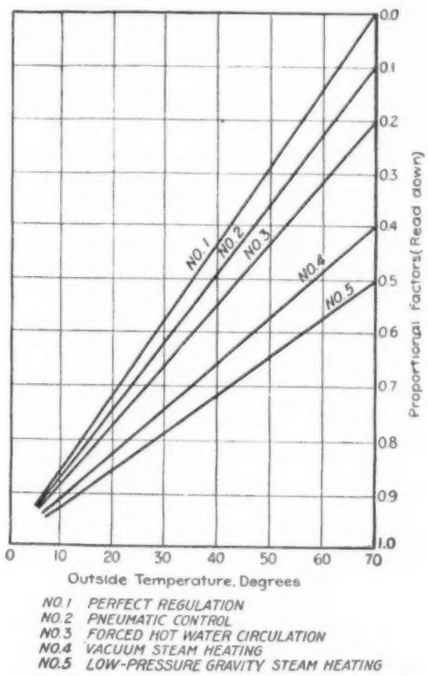


FIG. 1. POSSIBLE FACTORS FOR DIFFERENT TEMPERATURES

steam used to warm the building, at other outside temperatures, we have very little reliable data to fall back on. If the radiating surface were accurately designed for zero weather and the amount of surface could be changed to suit all variations of outside temperature, it would be a simple matter to compute the steam for all outside conditions, being very nearly proportional to the difference between the inside and outside temperatures.

As a matter of fact, this is not the case at all. In a building heated with direct steam, if properly designed, the rooms will have a temperature of 68 to 70 deg. when it is zero outside; but if steam is kept up in the building during the entire season, the steam used will vary from that actually required by an amount depending upon the care exercised by the occupants in attention to the radiators. Some will sit in overheated rooms and others will throw open the windows, while a small proportion will regulate the temperature by radiator valves. If perfect regulation could be maintained, the proportional weight

of steam for any given outside temperature could be read from line No. 1, Fig. 1. For example, if the weight of steam required per hour in zero weather is represented by 1, the proportional weight for +10 deg. will be 0.86 and 0.43 for + 40 deg., and so on.

What is required is a correction factor based on carefully conducted tests that will give the weight of steam actually used for the average conditions in practice. In an office building the amount of steam wasted will vary within small limits, but tests made in three or four buildings of the same type having the same kind of equipment, would establish a relation between the steam actually used (line No. 5 for example) and that theoretically required for different outside temperatures.

In similar buildings, equipped with return-line vacuum systems (line No. 4), regulation is under the control of the engineer to some extent, and if graduated supply valves are used on the radiators, the occupants will make a greater effort to vary the amount of steam, thus eliminating some of the wastes and approach more nearly the theoretical line 1. With a forced hot-water system, conditions would be still nearer the ideal (line No. 3) because the matter of regulation is under the control of the engineer to a greater degree than with either "low-pressure" or "vacuum" steam. Ideal conditions are most nearly reached with the pneumatic system of automatic control in connection with either steam or hot water (line No. 2). When in good adjustment, about the only heat wasted is the radiation from the mains and risers when the radiators are shut off, and this occurs only when the outside temperature is above 55 or 60 deg., as the heat given off from this source is largely utilized in warming the building, although perhaps not distributed to the best advantage.

Tests Under Operating Conditions

Tests made in office buildings for these four conditions, and the results reduced to factors for multiplying the ideal steam requirements for different outside temperatures, would have great practical value. In like manner, tests could be made in hotels, department stores, shops and factories, placing valuable data at hand for all, for no true comparison can be made without them. Knowing this relation, the probable weight of steam may be estimated from average temperatures for corresponding days or periods taken from the Weather Bureau charts for the given locality. The results given by the lines in Fig. 1 are assumed and are given simply for purposes of illustration.

The object of the tests suggested is to obtain factors from *actual* observations extending through one or more seasons with which to replace the *assumed* values given in connection with the curves.

The method of making tests and the results obtained may easily be reduced to a working basis. As there must necessarily be some variation in different buildings, there would be no advantage in carrying out tests of greater refinement than actual conditions call for; therefore delicate equipment is not needed. The data consist of outside temperature readings at regular intervals and a measurement of the weight of steam condensed in the heating system.

The best way to obtain a set of temperature readings is with a recording thermometer that gives a continuous record for the 24 hr. If an instrument of this kind is not available, it is usually possible for the engineer to obtain access to the records of one located in the same city or town, where temperature conditions are practically the same, or as the records are needed only at the end of the season for making the final computations, the chances are usually good for making this arrangement with the local Weather Bureau.

In measuring the steam, a separator, calorimeter and water meter are necessary. The separator usually forms a part of the regular equipment of a modern exhaust heating plant, as it is necessary to remove the oil before turning the exhaust into the heating main. This of course removes the greater part of the entrained moisture, but

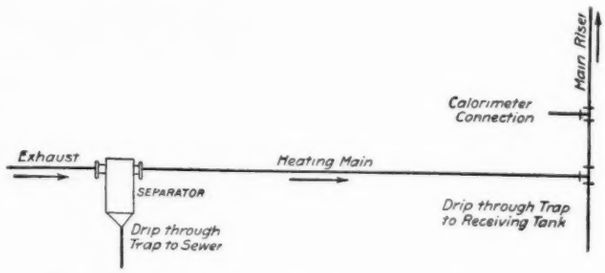


FIG. 2. SEPARATOR CONNECTION IN MAIN LINE

to determine more accurately the weight of steam condensed in the radiators, the percentage of moisture should be obtained by using a calorimeter connected into the main near the base of the main riser.

There will be some condensation in the horizontal main and riser, but most of this will drain to the bottom of the riser and be trapped directly to the receiving tank without passing through the meter. The steam condensed in the radiators, and which it is desired to measure, will come back through the main return pipe. This is easily measured by a meter connected into a bypass in the main return near the receiving tank. The water measured by the meter in a given time, less the moisture in the steam as given by the calorimeter, will be the weight condensed in the radiators.

It will not be necessary to make frequent tests of the quality of the steam as this will not vary greatly from day to day, but a sufficient number of tests should be made under different working conditions to determine a fair average for varying outside temperatures and periods of the heating season. A good arrangement is shown in the diagram in Fig. 2.

The "separator" type of calorimeter is best adapted to the testing of steam at very low pressures. It is simple in construction and easily manipulated, no reading of pressures or temperatures being required. When the pressure of the steam in the heating main is only slightly above or below that of the atmosphere, it will be necessary to connect the discharge from the calorimeter with a small condenser, which may be improvised from a small feed-water heater of simple construction. The general method of making the connections for the calorimeter is shown in Fig. 3. The quality of the steam is determined by the weights of water collected from outlets *A* and *B* in a given length of time. Complete instructions on the method of using the separator calorimeter may be obtained from any good handbook on testing steam plants.

The approximate weight of steam condensed in the radiating system may be determined directly from the

meter readings in the return by deducting from 2 to 5 per cent. for entrained moisture under average conditions. Sometimes, especially where a vacuum is maintained on the return, the steam supplied to the radiators is dry, or even slightly superheated, owing to the drop in pressure in passing from the engine cylinders into the heating mains.

Computations Involved—For example: Take a set of assumed readings and work out the necessary computations for putting the result of the tests in practical working form; this being simply to show the method of making the computations from actual readings.

In making the tests, select one of the coldest days of the season and see that all of the radiators are turned on. When the inside temperature reaches 70 deg., maintain this condition as nearly constant as possible for 3 or 4 hr., opening windows to some extent, if necessary, but keeping all radiators turned on during the test. Determine the quality of the steam during this period as desired with a calorimeter and note the meter readings at the beginning and end of the test. The gallons of water passed through the meter, multiplied by 8.3 and by the quality of the steam, and divided by the length of the test, in hours, will give the weight of steam condensed per hour under maximum working conditions, which is usually designed for an outside temperature of zero.

Suppose, in making the regular daily tests, a recording thermometer has been used. Look over the records carefully and note all periods where the outside temperature has averaged +10 deg. for periods of, say, 3 hr. Make a list of these periods, giving the date and time of day on which they occur. Next turn to the meter records and note how many gallons of water have been returned from the heating system during each of these 3-hr. periods.

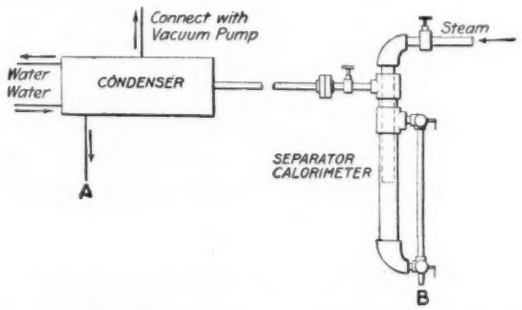


FIG. 3. CALORIMETER AND CONDENSER CONNECTIONS

Find the average of these and reduce to pounds per hour, as before, by multiplying by 8.3 and dividing by 3 hr., then correct for moisture. Place this final result, which represents the average weight of steam condensed in the heating system per hour when it is +10 deg. outside, in a column opposite +10 deg., for use in plotting a curve to be described later. Proceed in the same manner for 20, 30, 40, 50, 60 and 70 deg. To illustrate: Suppose the test for maximum conditions (all radiators turned on) shows 4 per cent. of moisture in the steam and that 2,200 gal. of water have passed through the meter in 3 hr. This shows that under maximum working conditions $\frac{2{,}200 \times 8.3 \times 0.96}{3} = 5{,}866$ lb. of steam is condensed per hour in the heating system.

Suppose also the temperature records show that during the season there have been twelve 3-hr. periods in which the outside temperature has averaged +10 deg., and that the quantities of water registered by the meter during these same periods are as follows: 1,800, 2,100, 2,000, 1,900, 1,850, 2,050, 1,950, 2,000, 1,850, 2,100, 2,000, 1,950 gal. The average of these quantities is 1,962 gal. per 3 hr. or $\frac{1{,}962 \times 8.3}{3} = 5{,}428$ lb. per hr. If calorimeter tests show an average of 4 per cent. of moisture, the actual weight of steam condensed in the heating system per hour is 5,428 × 0.96 = 5,211 lb. In like manner suppose the average quantities of steam condensed per hour for other outside temperatures are found to be as follows:

TABLE 1. AVERAGE STEAM CONDENSED PER HOUR

Deg.	Lb.	Deg.	Lb.
+20	4,988	+50	3,712
+30	4,582	+60	3,306
+40	4,118	+70	2,900

Plotting these various results, we have curve No. 1 in Fig. 4. Curve No. 2 represents ideal regulation, and assumes that all the radiation is shut off when the outside temperature reaches 70 deg.

Reading from curve No. 2 we have the following weights of condensation per hour for perfect regulation with varying outside temperatures:

TABLE 2. CONDENSATION WITH PERFECT REGULATION

Deg	Lb.	Deg.	Lb.
+10	5,040	+50	1,700
+20	4,200	+60	860
+30	3,360	+70	0
+40	2,540		

Similarly tests could be made in buildings heated with vacuum steam, forced hot water, and both steam and hot water systems equipped with pneumatic control, and curves plotted similar to No. 1 in Fig. 4 and the ratios determined as given in Table 3. Enough tests should be made of typical buildings with different systems of heating to establish reliable average ratios for general engineering use.

TABLE 3. RATIOS OF ACTUAL TO THEORETICAL REQUIREMENTS

Deg.		Deg.	
+10	5,428 ÷ 5,040 = 1.077	+40	4,118 ÷ 2,540 = 1.621
+20	4,988 ÷ 4,200 = 1.188	+50	3,712 ÷ 1,700 = 2.183
+30	4,582 ÷ 3,360 = 1.363	+60	3,306 ÷ 860 = 3.844

Before plotting the theoretical curve for any given building it is necessary to run a test of 3 or 4 hr. with the entire radiation turned on and with a sufficient number of windows open to maintain a fairly constant inside temperature of 70 deg. while the quality of the steam is tested and the condensation measured and corrected as already described. A very close approximation of the weight of steam condensed per hour under maximum conditions may be obtained by the formula,

$$W = \frac{E \times R}{L}$$

in which

W = Pounds of steam condensed per hour;

E = Radiation per square foot per hour, which may be taken as 250 B.t.u. for low-pressure gravity steam (2 lb. gage), 240 for vacuum steam and 220 for forced hot water heated by steam at atmospheric pressure;

R = Square feet of direct radiation in the entire building;

L = Latent heat of steam at given pressure = 966 for 2 lb. and 970.4 for atmospheric pressure.

It will be necessary to use an approximate formula for computations in connection with a proposed building, and

the same method may generally be used with sufficient accuracy for most buildings already constructed in which it is proposed to install a power plant in connection with the heating.

After plotting the theoretical curve, the weight of steam required at different outside temperatures may be read from the curve. These quantities multiplied by the corresponding ratios for the type of building and system of heating to be used will give the actual steam requirements under the same conditions.

With this data available, it will be easy to make a fairly accurate comparison between the available exhaust from the power plant and the steam required for heating throughout the entire season. A set of ratios for ready and convenient use may be computed as follows:

Assume that with perfect regulation of inside temperature the weight of steam condensed per unit of time in the radiators will vary directly as the difference between the inside and outside temperatures, which is sufficiently accurate for all practical purposes. Next, assume the weight condensed per hour per square foot of radiation when it is zero outside (a difference of 70 deg.) to be represented by 1. Then for +10 deg., the weight condensed will be $\frac{60}{70} \times 1 = 0.857$, and for +20 deg. it will be $\frac{50}{70} \times 1 = 0.714$, and so on. If the ratios in the last column of Table 3 represent the relation between the actual steam requirements with a given type of building and system of heating and the requirements with perfect regulation, then these ratios multiplied by the ideal steam requirements for corresponding outside temperatures will give a factor for determining at once the steam requirements for any given outside temperature under actual working conditions.

For example: A given building is heated by a system of direct low-pressure steam with gravity return of condensation. The surface is proportioned to warm the building to 70 deg. in zero weather and contains a total of 10,000 sq.ft. Assuming a radiation of 250 B.t.u. per sq.ft. per hr. under maximum conditions, what weight of steam will be required per hour for warming the building when it is +20 deg. outside? With perfect regulation the weight of steam condensed per square foot of surface per hour would be $\frac{250}{966} \times \frac{50}{70} = 0.185$ lb. The ratio for an actual system of this kind at +20 deg. is 1,188 (from Table 3). Hence, the total weight of steam required will be $0.185 \times 1{,}188 \times 10{,}000 = 2{,}200$ lb. per hr.

For convenient use, the ratios in the last column of Table 3 and those for different outside temperatures with perfect regulation may be combined, as in Table 4.

TABLE 4. COMBINING TABLES 2 AND 3

Deg.		Deg.	
+10	$\frac{60}{70} \times 1.077 = 0.923$	+40	$\frac{30}{70} \times 1.621 = 0.695$
+20	$\frac{50}{70} \times 1.188 = 0.850$	+50	$\frac{20}{70} \times 2.183 = 0.624$
+30	$\frac{40}{70} \times 1.363 = 0.779$	+60	$\frac{10}{70} \times 3.844 = 0.550$

The factors in the last column of Table 4 furnish a ready means of closely approximating the weight of steam actually required per unit of time for any outside temperature for the special type of building and form of heating system for which the table is prepared. For if 2,000 lb. of steam per hour is required for heating a given building in zero weather (either measured or computed), $2{,}000 \times 0.695 = 1{,}390$ lb. per hr. will be required when it is +40 deg. outside, and so on for other outside temperatures.

These factors may be plotted in such a curve, as Fig. 1, thus giving values for all intermediate temperatures. The factors given in Table 4 (last column) correspond most nearly with curve No. 5 in Fig. 1, although not exactly, because based on slightly different assumptions as to rate of condensation.

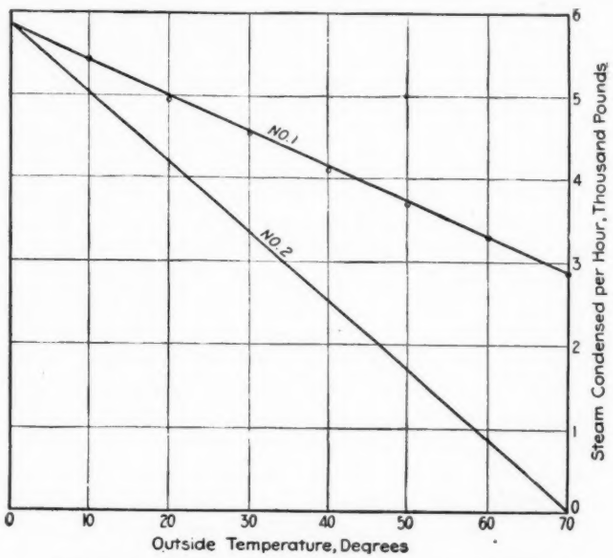


FIG. 4. RATIO OF THEORETICAL TO ACTUAL HEAT DEMAND

It should be mentioned again that the values given in both curves and tables are not for actual use but for purposes of illustration, although an effort has been made to take all assumption within reasonable limits.

The various suggestions given regarding the carrying out of the actual tests and the tabulation of the data thus obtained are offered simply as a guide and can undoubtedly be improved upon in many ways by those in a position to take up the work.

Velocity or Pressure?

By Lieut. Henry S. Eyler, U. S. N.

"Those pumps were figured to deliver the water," asserted the factory foreman.

"We made the calculations ourselves," agreed the head draftsman.

"But we aren't getting the amount we need," growled the superintendent. "Let's go over the proposition. As this blueprint shows, we have two pumps with 4-in. discharges flowing into a 6-in. pipe. The lift is 80 ft. and the 6-in. delivery pipe is 800 ft. long. Each pump is rated at 475 gal. per min. and gives that, running separately. Are you sure that the delivery pipe is large enough?"

"We made out the specifications," insisted the head draftsman.

"I have it," said the foreman, suddenly. "The two discharge streams are bucking each other, expending half their energy pushing in opposite directions. Look at the plan, and it is as plain as the nose on your face. Why didn't we think of it before?"

The superintendent and the head draftsman bent over the blueprint.

"I believe he's right," agreed the latter.

"It does look reasonable," admitted the superintendent. "Put a 'Y' in place of the discharge tee to allow the two streams to travel in nearly the same direction, and you ought to get the 950 gal. or thereabouts."

The change was made, and the three foregathered in the superintendent's office a few days later.

"Didn't work," and the foreman shook his head.

"It ought to," declared the head draftsman, doggedly.

The superintendent turned to the civil engineer, who had been called in for consultation.

"Listen," said the superintendent, and he outlined the difficulty.

"Why, you're all wrong," stated the civil engineer; and he showed them these facts:

The useful energy transmitted by the pump is converted into potential energy (pressure head H) and kinetic energy (velocity head h). When discharging at the rate of 475 gal. per min. through a 4-in. pipe, the velocity is 12.5 ft. per sec. and the velocity head corresponding to this is equal to $\frac{v^2}{2g} = \frac{156}{64.32} = 2.4$ ft. The pressure head at the pump is 50 lb., which corresponds to 115 ft. Therefore, the total amount of lost energy, if the velocity head in the discharge pipes is entirely lost, is 2.4 ft. out of 117.4 ft., or approximately 2 per cent.

Consider now the discharge through the 6-in. pipe, which is 800 ft. long and has a static lift of 80 ft. The frictional loss when delivering 475 gal. per min. is 20 ft. per 1,000 ft., or 16 ft. in 800 ft. Adding the static head makes a total of 96 ft., or (divided by 2.3) 42 lb. This shows that the pipe is large enough to take the discharge from one pump with some margin to spare.

In discharging the two pumps, 475 gal. per min. each, total 950 gal. per min. through the 6-in. pipe, the frictional loss will be not less than 70 ft. per 1,000, or 56 ft. for the 800 ft., which is equivalent to 24 lb. The 80-ft. static head corresponds to 35 lb., and this, added to the 24 lb. frictional loss, makes 59 lb. required at the pump, which is more than the pumps have.

To figure the actual capacity with 50 lb. at the discharge of the pump, subtract from 50 lb. the static head of 35 lb., leaving 15 lb., which is available for overcoming friction. The discharge rate would then be 740 gal. per min., or a little over one and one-half times the capacity of a single pump.

It looks as if the pipe line had been intended to carry only the discharge from one pump, and if a larger supply is needed it will be necessary either to speed up the pumps so that they will deliver at a greater pressure, or to put in another pipe.

He finished, and the superintendent phoned the chief clerk to bring him the pump requisition. There was the answer: "One pump only is to be operated at a time; the other is to be held in reserve."

"You see, what counts is pressure, not velocity," explained the civil engineer.

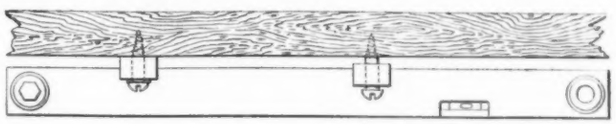
"Who'd 'a' thought it?" said the foreman.

⁂

Standard Welded Steel Pipe is made of steel of approximately the following physical properties: Tensile strength, 50 to 62,000 lb. per sq.in.; elastic limit, upward of 30,000 lb. per sq.in.; elongation in 8 in., not less than 20 per cent.; reduction in area, not less than 50 per cent.

Self-Aligning Ears on Ellison Draft Gages

To prevent glass breakage all Ellison draft gages now have self-aligning ears. Take, for example, the standard differential gage, which has two supporting ears at the top of the frame. The slotted ear is set a trifle farther back than the round-hole ear and is screwed down with a washer under the screw head. The round-hole ear is cupped on the back and rides free on a shouldered



EAR ALIGNMENT, MODEL 1916

screw. The ear clears the board in back and the screw head in front and is free to roll or move laterally, thus compensating for any ordinary uneven surface under the slotted ear. This relieves the frame and the glass of twisting strains and will prevent the breakage so common with the usual method of support.

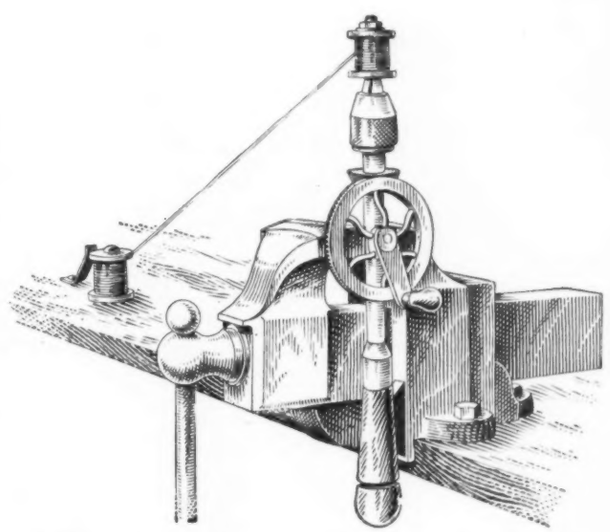
When wood screws are used, the screw for the round-hole ear is bushed, machine screws being shouldered. Special capped bolts are furnished for slate and marble gage boards.

⁂

Handy Coil-Winding Kink

By W. W. Parker

It is always a long and tedious job to wind a coil for a solenoid or electromagnet by hand, especially if the wire is very small. It is also difficult to make a good job of it by this method. Unless a lathe is at hand, the workman usually finds it difficult to conceive some mechanical means of turning the coil while winding.



METHOD OF HOLDING HAND DRILL TO WIND A COIL

The illustration shows what has proved to be a very handy as well as a quick and satisfactory means of winding coils of small size. A hand drill is securely clamped in a vise, as shown. For holding the spool that the coil is to be wound on, a machine screw or small bolt

is used that is long enough to fit in the drill chuck and extend up through the coil. The head of the bolt is cut off and this end fitted securely into the drill chuck. The spool for the coil is set over the bolt and held down against the chuck by a washer and nut on the thread end of the bolt. The spool of wire from which the coil is to be wound is set over a heavy nail driven into the bench. The workman is now free to guide the wire on the coil with one hand, while he turns the drill with the other, and should be able to do a neat job.

Practical Talks on Controllers--Reversing Switches

By A. A. Fredericks

SYNOPSIS—This article is the first of a series of practical talks on controllers for electric motors. Each article will treat some particular type of industrial controller, or some phase of this subject, in a practical way. A description is given herewith of different types of reversing switches in general use on elevator and industrial controllers for reversing electric motors.

A direct-current motor may be reversed by changing the direction of the current through the armature or the field winding. Fig. 1 shows diagrammatically a shunt motor connected to a starting box. The direction of the current through the various parts is indicated by the arrow-heads. The same connections are shown in Fig. 2, with the armature connections crossed. This changes the direction of the current through the armature coils, which will make it revolve in an opposite direction to that in Fig. 1, as indicated by the curved arrows. Interchanging the field connections as in Fig. 3 will also change the rotative direction of the armature.

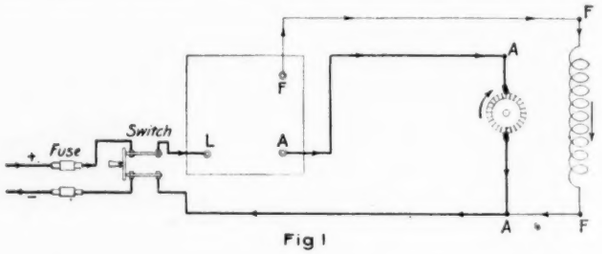


Fig 1

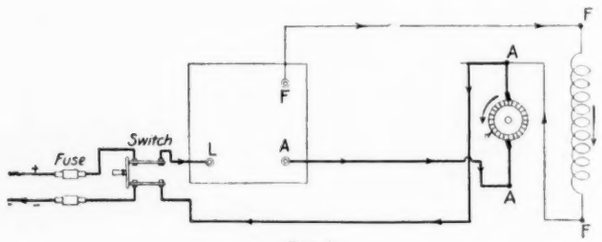


Fig.2

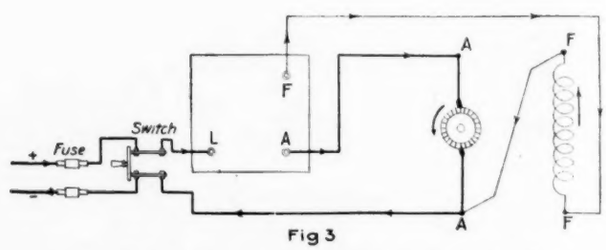


Fig 3

FIGS. 1 TO 3. CONNECTIONS FOR CHANGING DIRECTION OF SHUNT MOTOR

In a large percentage of installations the electric motor is required to run only in one direction. The only time it is reversed, if at all, is when first installed, to get the correct direction of rotation. There are, however, a great many applications of the electric drive which require frequent reversing of the driving medium. Examples of this are found in elevators, electric-railway service, printing presses, machine tools, etc.

When frequent reversing of the motor is required, some convenient and effective means must be provided. One of the simplest and cheapest means for accomplishing this, and usually the most likely to be at hand, is a two-pole double-throw knife switch. In Fig. 4 a shunt motor is shown connected to a two-pole double-throw knife switch. The arrow-heads indicate the direction of the current through the armature and field coils. The switch is shown in the opposite position in Fig. 5, and the arrow-heads show that the current is reversed through the armature from that in Fig. 4, but the same direction in the field coils.

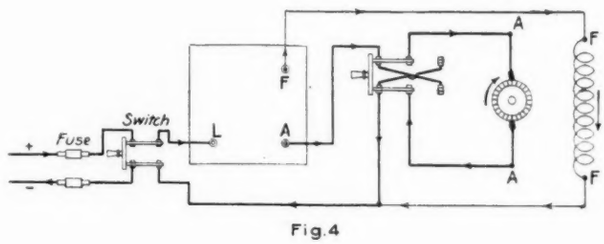


Fig.4

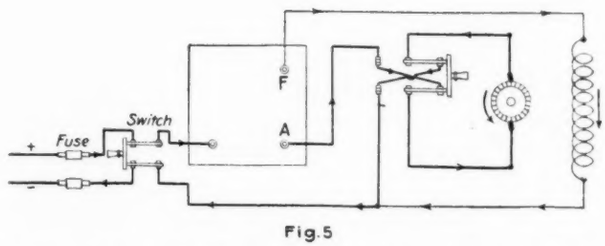


Fig.5

FIGS. 4 AND 5. REVERSE-SWITCH CONNECTIONS FOR A SHUNT MOTOR

What is known as a five-point switch is shown in Fig. 6. The blades are hinged at *a* and *b* and held together by an insulated bar *c*. It is obvious that this switch throws sidewise and not over, as the two-pole

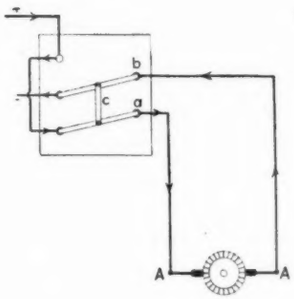


Fig. 6

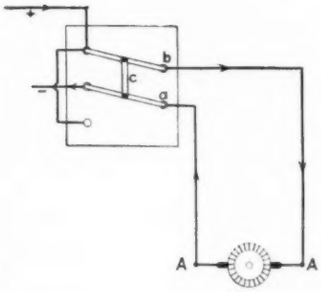


Fig. 7

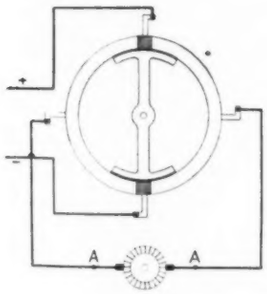


Fig. 8

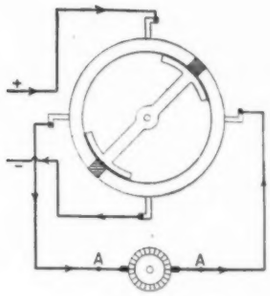


Fig. 9

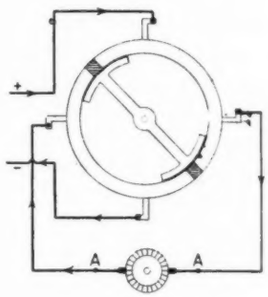


Fig. 10

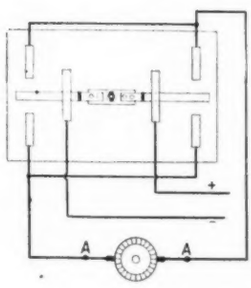


Fig. 11

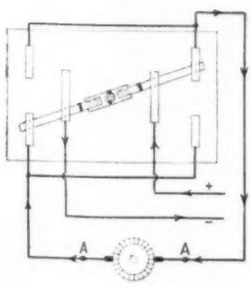


Fig. 12

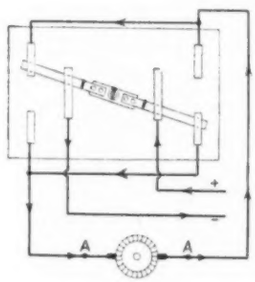


Fig. 13

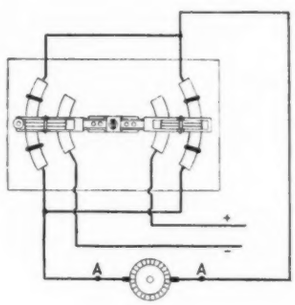


Fig. 14

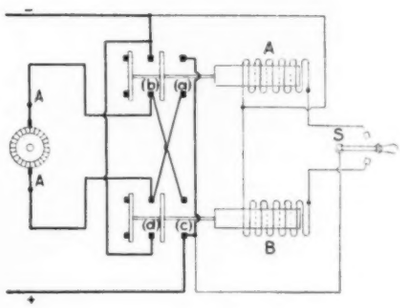


Fig. 15

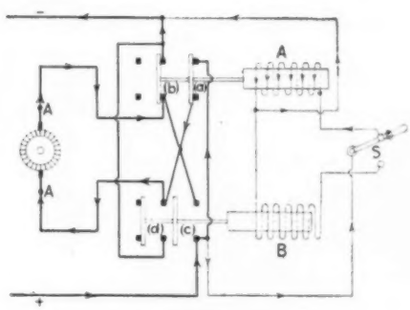


Fig. 16

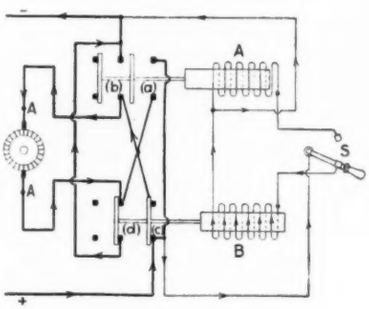


Fig. 17

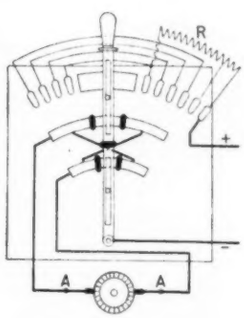


Fig. 18

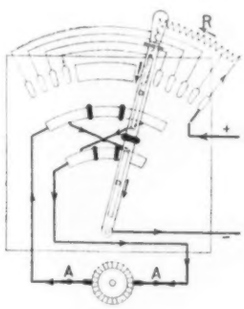


Fig. 19

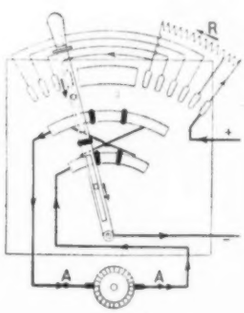


Fig. 20

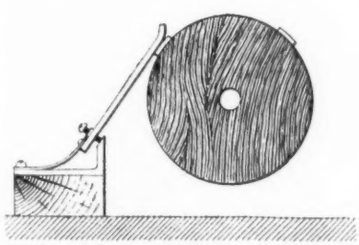


Fig. 21

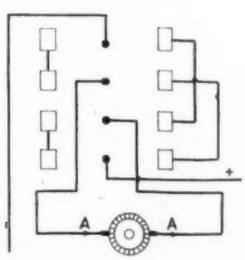


Fig. 22

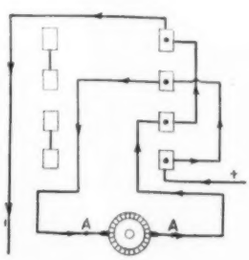


Fig. 23

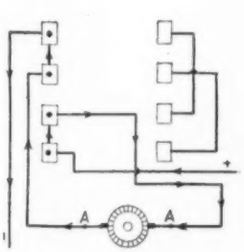


Fig. 24

FIGS. 6 TO 24. SHOW DIFFERENT TYPES OF REVERSING SWITCHES AND THEIR OPERATION

double-throw switch does. Fig. 7 indicates the opposite position. This type is used mostly on elevator controllers.

The diagrams, Figs. 8, 9 and 10, show another type of reversing switch, which at one time was used to a large extent on elevator controllers. It consists of two metal semi-circles insulated from each other and mounted so that they can revolve, although in actual practice they turn only about 45 deg. from the position shown in Fig. 8, which is the off position. Throwing the switch to the position shown in Fig. 9, current will flow through the armature in the direction indicated by the arrow-heads. In the position, Fig. 10, a reverse direction of the current is given, with a consequent reversal of the armature.

In Fig. 11 two knife blades are arranged on opposite ends of a crosshead. The knife blades throw into jaws similar to those on the ordinary knife switch. The operation of the switch is shown in Figs. 12 and 13, the arrow-heads indicating the direction of the current. A modification of this type is shown in Fig. 14. Here two insulated arms carry brushes which are held against surface contacts by flat springs. The operation of the switch is the same as that described in Figs. 11 to 13. Either type is used chiefly for elevator work. All the elevator-motor reversing switches described are connected to the elevator machine through a mechanism which operates them in their proper sequence with the other parts of the machinery. A great many controllers are made so that they may be electrically operated. Fig. 15 shows a diagram of an electrically operated reversing switch that has been used to considerable extent for elevator service. The operating switch S is located in the car. Closing it to the position shown in Fig. 16 will energize coil A, which will in turn draw up the core and close contacts a and b. The current will then flow through the armature in the direction indicated by the arrow-heads. If the operating switch is thrown to the opposite position, as in Fig. 17, coil B will be energized, closing contacts c and d and causing the current to flow through the armature in the opposite direction.

The foregoing are some of the common methods used for changing the direction of the current through the armature of a direct-current motor. They may be used equally well for changing the direction of a polyphase induction motor by connecting one phase of the motor and line as the armature and line are connected in the diagrams.

Fig. 18 shows a schematical diagram of a manually operated reversing controller for industrial purposes. The arm is made in two sections, one insulated from the other, and acts both as a means for cutting out the starting resistance and as a reversing switch. Figs. 19 and 20 show the controller in the two starting positions; the arrow-heads indicate the direction of the current, which will be seen to be in an opposite direction through the armature in one figure, to that in the other.

The type of reversing switch that is used in railway controllers or cylindrical controllers for industrial drives is shown in Figs. 21 to 24. It consists of a cylinder carrying insulated surface contacts that have contact fingers rubbing on them, as in Fig. 21. In the off position the contact fingers rest between the surface contacts, as shown in Fig. 22. Figs. 23 and 24 indicate the two running positions, the direction of the current in the armature being opposite in one case to that in the other.

"Uniflow" Return-Tubular Boiler

This boiler differs from other designs of return-tubular boilers in that the tube layout provides a large circulating space at each side, as shown in Fig. 1. This arrangement provides for a rapid circulation, and the spacing of the tubes permits of a greater number of them being put in a given diameter shell than with the ordinary tube spacing. According to the builders, the Uniflow Boiler Co., Harrison Building, Philadelphia, Penn., the

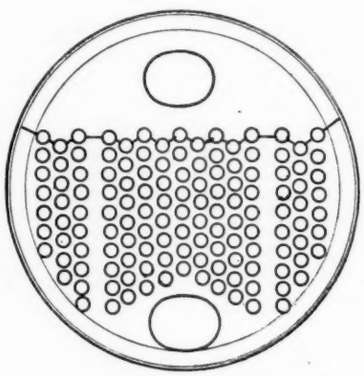


FIG. 1. TUBING OF UNIFLOW BOILER

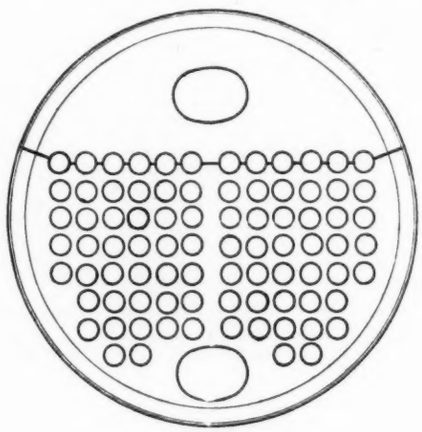


FIG. 2. TUBING OF ORDINARY BOILER

increase in horsepower is about 55 per cent.; that is, a 60-in. by 16-ft. return-tubular boiler, with the tubes spaced as in Fig. 2, would be rated at about 88 hp., and a Uniflow boiler, Fig. 1, of the same size would be rated at 136 hp., having 1,360 sq.ft. of heating surface. This boiler is built in units ranging from 75 to 608 hp. and is constructed in compliance with the American Society of Mechanical Engineers' Boiler Code.

Transformers in Parallel

The simple distributing transformer usually has two high-voltage leads and four low-voltage leads coming out from its windings, as indicated in Fig. 1. The schematic diagram of the windings and the way the leads are brought out are shown in Fig. 2. It will be seen that the two center leads of the low-voltage coils are crossed inside the transformer before they are brought out through the case. This does not make any change in connecting the two sections in series on the outside of the transformer, as indicated in Fig. 3, which is the same as connecting two batteries in series.

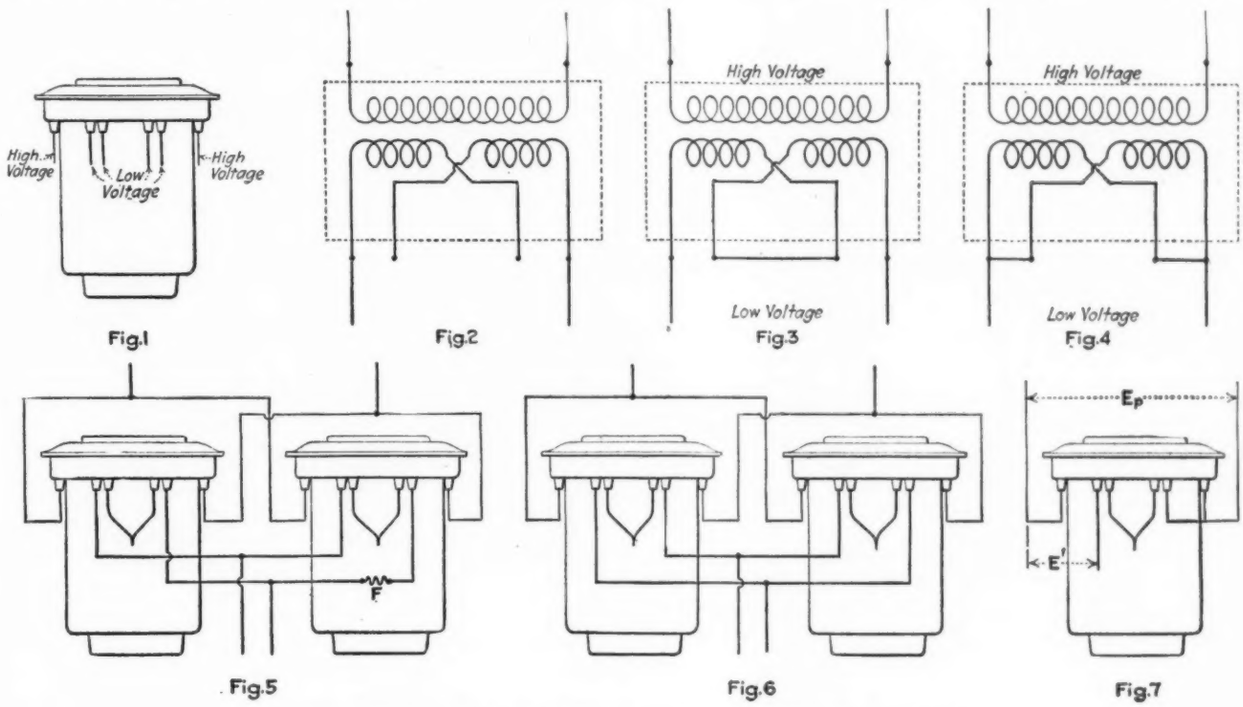
When the coils are connected in parallel, care must be exercised and adjacent leads connected together, as in Fig. 4. Looking at the connections from the outside of the transformer, it would appear as though the two sections of the winding were short-circuited, but the diagram shows that the right-hand terminals of each section

are connected together, also the left-hand terminals. This is just what is done in connecting batteries or other direct-current elements in parallel—like poles are connected.

Transformers to operate in parallel should be the same voltage, frequency, size and possess the same characteristics, which means that they should be of the same make. In connecting transformers in parallel, it is only necessary to observe the same rules as used for connecting two or more pieces of direct-current apparatus in parallel; namely, connect like poles to like poles. The question now arises which are like terminals on two or more transformers. This is easily determined in most cases. After the transformers are arranged symmetrically, as in Fig. 5, connect the right-hand terminals together and the left-hand terminals together and bring out a lead from each junction point, as indicated.

There is, however, a chance that one of the transformers may have its leads brought out in such a way as to cause a short-circuit when the transformers are connected, as shown in the figure. To guard against this a piece of small fuse wire may be connected, as indicated at F. If the connections are correct, the fuse will not blow when the transformers are made alive without load; otherwise the fuse will blow. In case of a wrong connection it may be remedied by crossing either the high- or low-voltage leads on one of the transformers, as indicated in Fig. 6. A better way would be to test the transformers and find out which has wrong polarity and correct it.

The polarity may be tested as represented in Fig. 7. Connect the high-voltage terminals to the line and with one terminal of the low-voltage coil connect it to the high-voltage winding, as indicated in the figure. Measure the electromotive force at E_P and E'. If it is greater at E' than at E_P, the transformer has the correct polarity; if less, the polarity is wrong and either the high- or the low-voltage lead must be crossed inside of the transformer. The test may be made with 110- or 220-volt current.



FIGS. 1 TO 7. SHOW DIFFERENT TRANSFORMER CONNECTIONS

Oil-Engine Operators

By Amon J. Fortner

A desire on the part of some gas- and oil-engine manufacturers to show an extremely low operating cost has led them to depreciate the importance of careful and intelligent attendance. As an extreme instance of this attitude might be cited the policy of one company in particular who advised buyers to employ men with no previous engineering experience to operate their machines.

In defense of this policy it was stated that a green man was less likely to cause trouble by attempting to make adjustments than one who had previously been engaged in engineering work. Any previous experience was declared by these people to be useless in the handling of their machines, and all repairs and adjustments were to be taken care of by an expert sent out by the manufacturing company until the new man became familiar with such work.

It is needless to remark that serious mechanical troubles followed and that the reputation of the engines for reliability suffered. Notwithstanding their policy of advising the use of unskilled attendants, every trouble that developed was laid up against the man in charge; and when experts were sent to straighten out any difficulty, about the first suggestion made to the owner was "replace the engineer."

One manufacturing company made the claim in their sales bulletins and through their selling representatives that "one-tenth of one man's time" was sufficient to keep one of their engines in first-class operating condition, and on the strength of this statement companies installed these machines, fully expecting to have the engineers earn about nine-tenths of their salaries outside of the engineering department.

It is certain that any misrepresentations made as to the power, economy, maintenance or attendance during

the sale of an engine will result in a flare-back that will injure the company employing such tactics. The truth of this assertion has been effectively demonstrated in the introduction of the crude-oil engine. In a locality familiar to the writer, much undeserved prejudice has been created against the high-economy oil engine by troubles that could have been prevented with a more liberal power margin and an experienced operator.

This prejudice, played upon to the utmost extent by the electric-power companies, has prevented the general adoption of these engines in a field where fuel prices and conditions are favorable for their use. The theory of cheap attendance, or nonattendance, has resulted probably from practices common in the operation of gasoline engines, but engine builders would do well to let the oil engine stand upon its true merits. Let the fuel economy be the one all-important factor in comparison with other prime movers, and insist that none but the best is good enough in the way of attendance.

There are exigencies that arise in the handling of oil engines that can be met successfully only by experiences gained in previous happenings of like nature. Intimate familiarity acquired only through months of attendance can enable the operator to distinguish trouble sounds and determine their source in time to prevent serious consequences. Lack of experience and possibly intelligence caused the temporary failure of a new engine under light load when each moment of delay meant a high overhead labor expense. A visit by the expert revealed the fact that the attendant had rendered the high-stage air compressor inoperative by throttling the air intake and that the high-pressure discharge valves had accumulated so much carbon that it was difficult to get them into working condition.

It was an erecting and operating man of many years' experience who increased his store of knowledge by pumping up a heavy pressure on a dead engine that had the torch burning under the hot-bulb. He wished to ascertain if the fuel valve leaked—and did—for the charge back-fired through the open air intake and blew the crank case into pieces.

During the fifth year of his experience another engineer learned that the timing of the engine in his charge had a distinct bearing upon exhaust-pit explosions. In the meantime one disastrous accident had occurred.

An inactive conscience allowed an engineer to sleep so soundly on duty that one cylinder of a twin engine quit working and the full load on the other cylinder soon burned up a number of bearings.

These are a few of the things occurring to demonstrate that it is not possible to get too much experience or to be too careful in the handling of the oil engine.

Taking it all in all it is a full-grown man's job to properly care for and keep in operation any high-economy oil-engine plant. The operator must be able by natural ability and past experience to go surely and quickly to the seat of impending trouble. When the engine is grumbling at overload, he must be able to understand its language and must determine whether the overload is due to poor mechanical condition, poor lubrication or to power demands beyond the engine shaft. The best type of oil-engine operator is the man who makes the greatest headway in reducing the load requirements without lowering the efficiency and output of his plant, well knowing that his reward will be days of peace in just such measure as he succeeds in giving his engine a fair deal.

When all the methods brought over from gasoline-engine practice have disappeared, when engine builders and power users together make such power ratings as will give the engine a moderate load, and when intelligent, experienced and conscientious operators are looked upon in the light of excellent insurance for a valuable investment—then will the oil engine fully come into its own. The saving that may be effected under these conditions will be a revelation to many power users who are now suspicious of everything carrying the word Diesel in its cognomen.

JUST FOR FUN

AN UNDERFED STOKER

Brake for the Turbines

About thirty students visited my power plant one evening and were duly shown over the place. After the inspection one of them said: "Will you explain for what purpose on the turbo-alternators you use the Westinghouse brake? Is it for stopping them quickly in case of emergency?"

He said he had observed a Westinghouse-brake gage on the switchboard and pointed to a kilowatt-indicating meter, the only one made by the British Westinghouse Co., all of the others being different. He had evidently associated the name "Westinghouse" with the brake of that name.—F. S. James, Durham City, England.

A.—HANDY MAN—Electrician, engineer, fireman, carpenter, house and sign painter, decorator, plumber, cement finisher and all other kinds of work; must be a hard worker; hours 7 a.m. till 6 p.m.; $12 per week. Munro Hotel. Apply to engineer.

This is not a joke. It appeared in the Cincinnati *Enquirer* for Aug. 29, 1916.

A High Vacuum in Reciprocating Engines gives but little economy, because the specific volume of the steam increases rapidly as the pressure is reduced, especially at the lower pressures, and the engine cylinders cannot for practical reasons be sufficiently enlarged to accommodate this volume.

Craig Marine Diesel

SYNOPSIS—A four-stroke-cycle engine embodying distinctive features designed to minimize heat troubles. It is of the high-speed type and weighs about 82½ lb. per horsepower.

The Craig Marine Diesel, built by the James Craig Engine and Machine Works, of Jersey City, is an engine of the four-stroke-cycle type embodying a number of features that distinguish it from the engines of foreign design built under license in this country. Among these may be mentioned the camshaft location and arrangements, auxiliary exhaust ports and valves, means for controlling the time of ignition and the opening of the fuel valve, a simple lubrication system and provision for observing the combustion in each cylinder. Two engines of this type are being constructed for U. S. submarines.

The engine here illustrated is rated at 200 b.hp. in six cylinders, or 33⅓ hp. per cylinder of 9½-in. diameter and 12-in. stroke, when running at the normal speed of 420 r.p.m.

With a view to providing accessibility and lightness together with rigidity, the frame is made up of stanchions with cross-bracings, mounted on a one-piece bedplate of box section and supporting a cylinder table upon which are carried the working cylinders and the compressor. Removable splash guards are fitted at the front and back.

Heat conditions have been minimized by providing auxiliary exhaust ports at the lower ends of the cylinders, thus releasing the exhaust gases near the end of the power stroke. The exhaust valves in the cylinder heads are thereby relieved of much of the heat to which they would ordinarily be subjected; they are in contact with the water-cooled seats for a longer period and do not open against internal pressure. Also the piston is exposed to the intense heat for a shorter period. By thus diverting the bulk of the hot gases from the exhaust valves, it has been possible, in the engines above 200-hp. rating, to dispense with the usual detachable cages, thereby leaving room to provide two exhaust valves of ample area, in the latest engines. Another point advanced by the designer is that the heat conditions of the exhaust chamber and the passageway in the cylinder head are not much different from those prevailing in the air-inlet passage; hence stresses due to unequal heat conditions are minimized.

Each of the lower exhaust passages has an exhaust valve operated by a camshaft at the back of the engine. This valve is closed during the suction and compression strokes, but is wide open by the time the working piston uncovers the exhaust port. In this way exhaust gases are prevented from being sucked back into the cylinder on the suction stroke and the valve is relieved from opening under pressure. The lower exhaust manifold is shown at *G*, Fig. 3.

Each cylinder head has a fuel-injection valve; two air-inlet and two upper exhaust valves (the 200-hp. engine has one inlet valve and one upper exhaust valve), each pair operated by a single rocker; an air-starting valve, and a relief valve. With the exception of the last-named the valves are of nickel steel. The rocker shaft for each cylinder is separate and carries two eccentrics, one for the air-starting valve rocker and the other for the fuel-injector valve rocker. The camshaft brackets and valve-operating gear are carried on the air-intake manifold.

The control camshaft *L*, Fig. 2, is in two sections, operated respectively by levers *C* and *C'*; the first serves the three forward cylinders and the second the three rear cylinders independently. Each section is connected by bell cranks and links to the rocker shafts of its respective cylinders. When levers *C* and *C'* are in the neutral position shown, the rocker shafts are turned so that the cams will raise the fuel-injection and the air-starting rockers to a nonoperative position, so as to clear

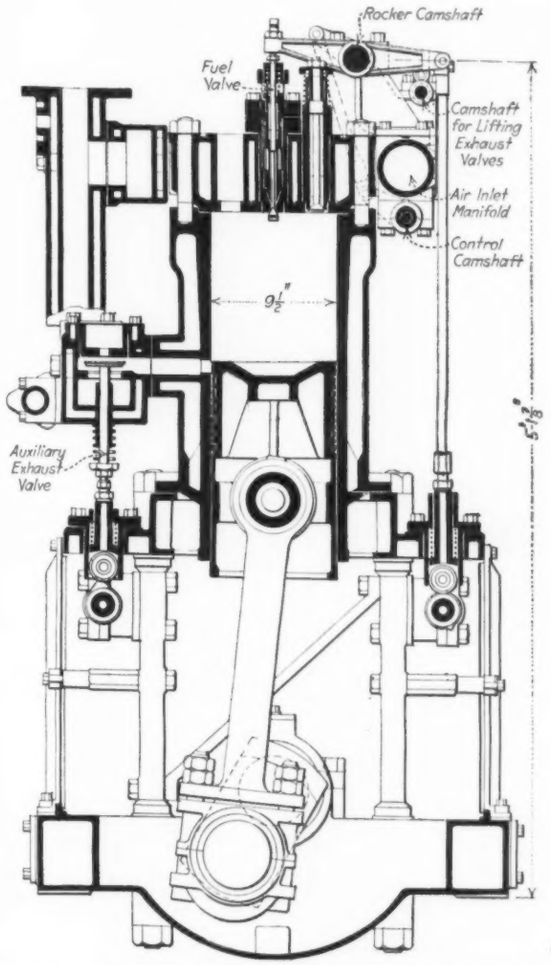
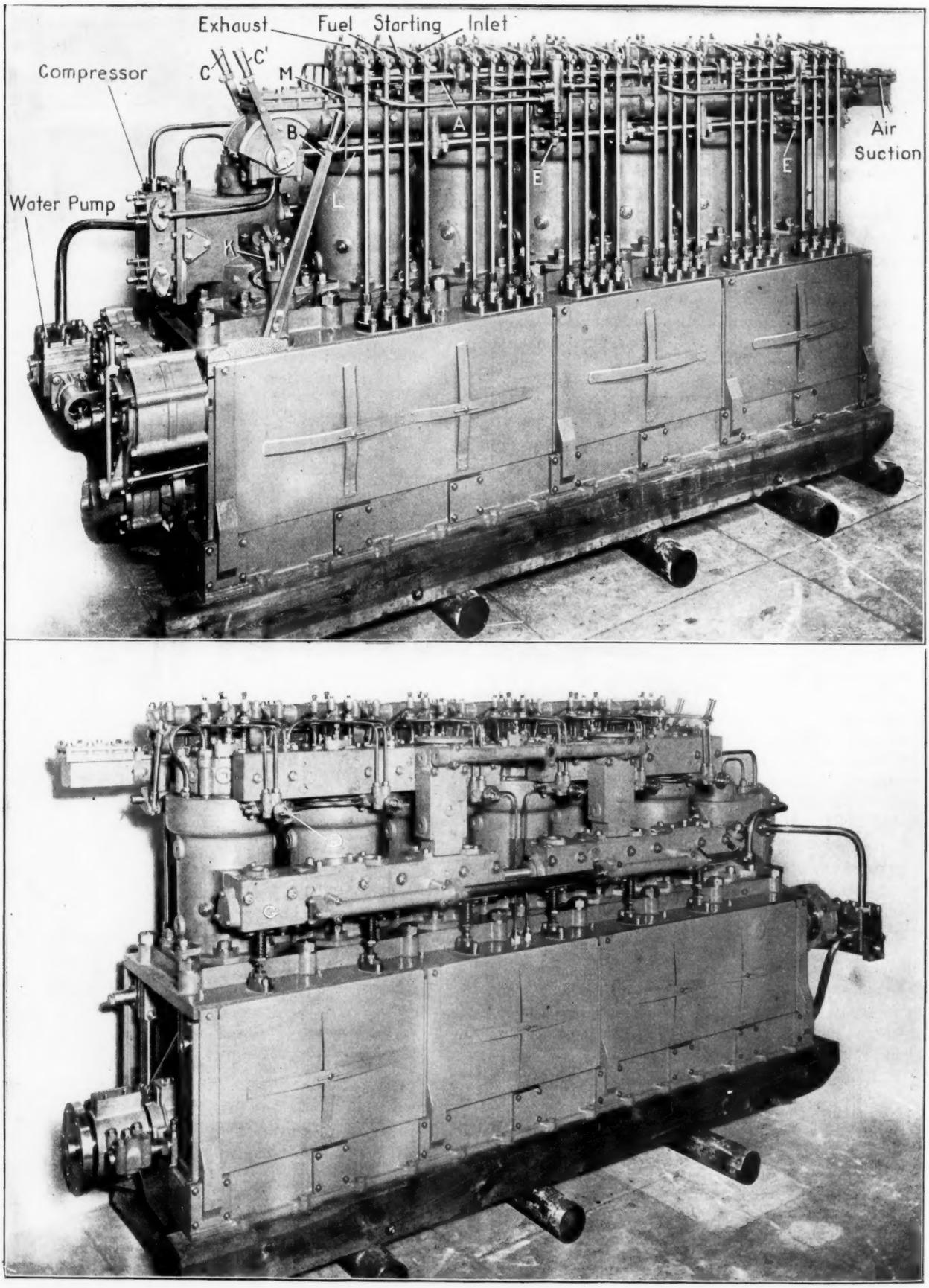


FIG. 1. TRANSVERSE SECTION THROUGH ENGINE

their valves, although they may still be actuated by the push-rods.

In starting, air is turned on from the starting bottles and levers *C* and *C'* are both brought all the way back (extreme left) from the neutral position, causing the rocker shafts to turn so as to make the starting valves operative, and opening the master air valves *E* in the air line. This admits air to all six cylinders in turn. When the engine has picked up on air, either *C* or *C'* is quickly shifted forward, cutting off the air in its group of cylinders and bringing the fuel-injection valves into action. When these three cylinders have picked up on



FIGS. 2 AND 3. SHOWING RESPECTIVELY FRONT AND BACK OF CRAIG ENGINE

oil, the other lever is shifted forward and throws the remaining three cylinders on fuel. There are several notches for the forward position of levers C and C' corresponding to different positions of the rocker cams, hence different openings of the fuel valve. This is very desirable at light loads as it avoids the injection of excess air and enables the correct proportion of air to fuel to be maintained at all loads.

The main camshaft is driven by gearing from the crankshaft and, through hardened cams and rollers

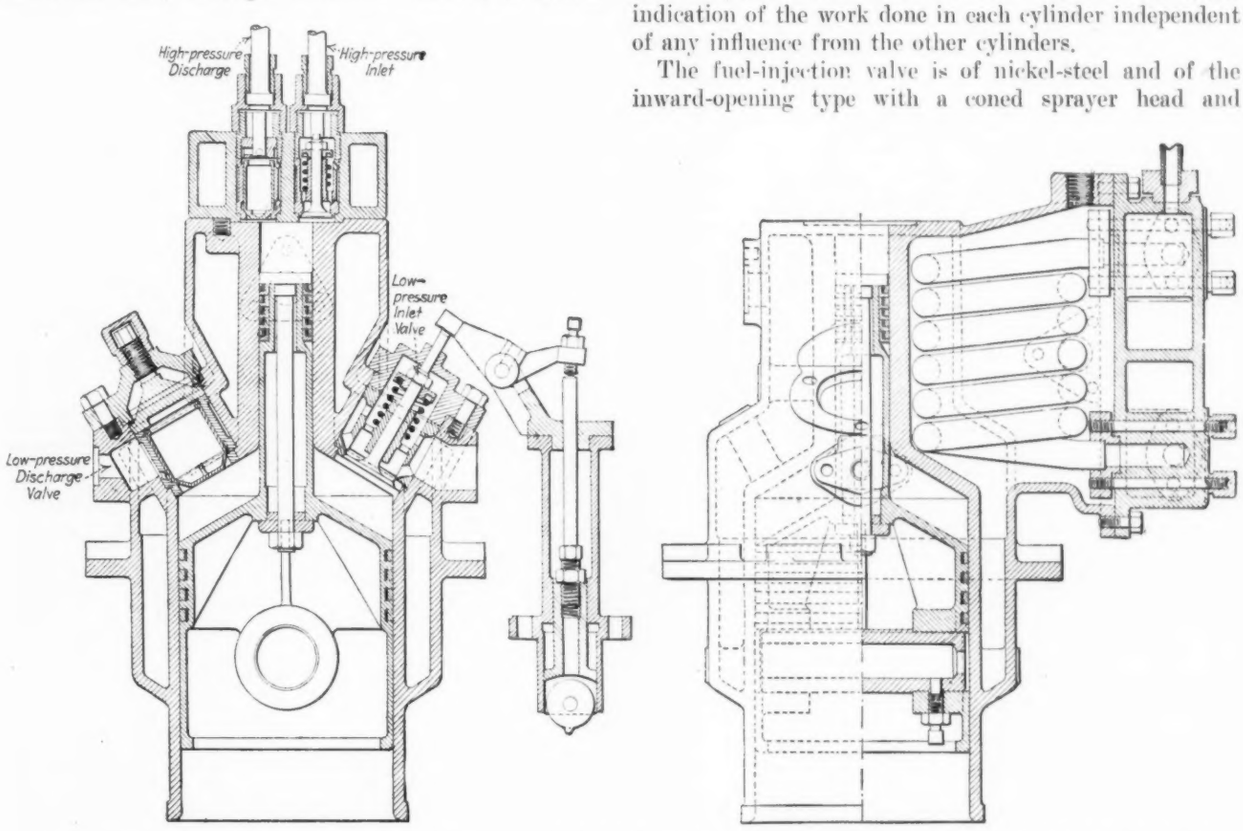


FIG. 4. SECTIONS THROUGH COMPRESSOR, SHOWING MECHANICALLY OPERATED LOW-PRESSURE INLET VALVE

operates the vertical push-rods. There are eight cams per cylinder, four ahead and four reverse, making forty-eight in all. By means of the reversing lever B the camshaft is slid endwise and the reversing cams are brought into position.

A small camshaft A operated by the lever M is provided for lifting the exhaust valves and thereby relieving compression when it is desired to bar over the engine by hand.

The compressor, which is carried on the cylinder table and driven off the main crankshaft, is of the two-stage tandem type with intermediate and final coolers and is provided with moisture and oil separators. The air-inlet valve of the first stage is mechanically operated from the front operating camshaft, as shown at K, Fig. 2 and also in Fig. 4. The discharge valve of the first stage is automatic, as are also the suction and discharge valves of the second stage, all being contained in removable cages. The high-pressure air is delivered directly to the blast bottle, and when full pressure is there built up, a valve in the line is opened, admitting a surplus to the starting bottles. When these are filled, the amount of air is cut down by controlling the compressor suction.

Fuel for the six cylinders is supplied by a single pump suspended within the crank case and operating on the controlled-suction principle. Adjustable distributors apportion the fuel supply to the individual cylinders. These will be seen at the back of the engine, Fig. 3.

A most convenient arrangement is provided for ascertaining the correct adjustment of the fuel to each cylinder, by means of exhaust test-cocks connected to the lower exhaust passages at each cylinder. Because of the lower exhaust valves these test-cocks afford a measurable indication of the work done in each cylinder independent of any influence from the other cylinders.

The fuel-injection valve is of nickel-steel and of the inward-opening type with a coned sprayer head and atomizer plates. As previously explained, it has a variable lift.

Salt water is drawn through the engine bedplate by a bronze pump of the piston type carried at the end of the engine and is supplied first to the compressor, thence to the lower exhaust manifold, to the cylinder jackets, the cylinder heads and the upper exhaust manifold. With the ample cooling spaces provided, it is possible to lay the hand on any of these parts without discomfort. The pistons are not cooled, but the main bearings are.

A very simple system of lubrication is provided, which also makes for cleanliness. The main crankshaft and lower connecting-rod bearings are supplied by wick feed with a wiper on the crank face. Sight-feed lubricators, similar to those employed on many steam engines, feed oil to each cylinder at a single point. This oil is picked up by a special piston ring, which distributes it over the inner surface of the cylinder and also through holes in the piston to the wristpin bearing, the wristpin being fixed in the piston with the bearing at the connecting-rod end. The camshaft bearings, rocker arms, push-rods, etc., all have oil holes which are supplied from time to time by the operator.

Including the flywheel, thrust block, air compressor and all piping, the engine weighs 16,500 lb., or about 82½ lb. per brake horsepower.

The guaranteed fuel consumption with oil of a heat value not lower than 19,000 B.t.u. is as follows: Full load, 0.5 lb. per b.hp.; ¾ load, 0.55 lb. per b.hp.; ½ load, 0.6 lb. per b.hp. The 200-hp. engine in operation has done somewhat better than the guarantee, developing a horsepower-hour on 0.46 lb. of oil, which figure represents good practice.

Passing of an Old Corliss Pumping Engine

By Warren O. Rogers

SYNOPSIS—George H. Corliss built five pumping engines. The third one is still in service at the pumping plant of the Lehigh Water Co., Easton, Pennsylvania. It was the first compound engine built by Corliss and will be replaced in the near future by a turbine-driven centrifugal unit. This pump has been in practically constant service for 35 years and is still in good condition.

George H. Corliss built but five pumping engines, the first in 1873. It was a failure, however, as far as economy in steam consumption was concerned. The third pumping engine was completed in 1875 and was the first compound engine ever built by Corliss, and the steam cylinders were the first steam-jacketed cylinders he ever made. The yacht designer, N. G. Herreshoff, conducted the test of this engine. He had recently returned from Europe, where he had seen many compound engines running, and it was doubtless his influence that made Corliss decide to build the compound pumping engine. This pump was sold to the Lehigh Water Co., Easton, Pennsylvania, and was installed at its pumping plant on the banks of the Susquehanna River in 1881, where it was operated night and day up to within 1½ years. During the last six years of its active service the pump was stopped on Friday afternoons just long enough to wipe it off. The machine so occupies the pumproom that a good photograph was difficult to get, but an idea of the general design of the pump can be obtained from Fig. 1.

An elevation of the pump is shown in Fig. 3. The dimensions are: Diameter of the steam cylinders, 9 and 18 in.; pump plungers, 9 in.; and stroke 2-ft. During a 12-hr. run the duty of the pump was 115,000,000

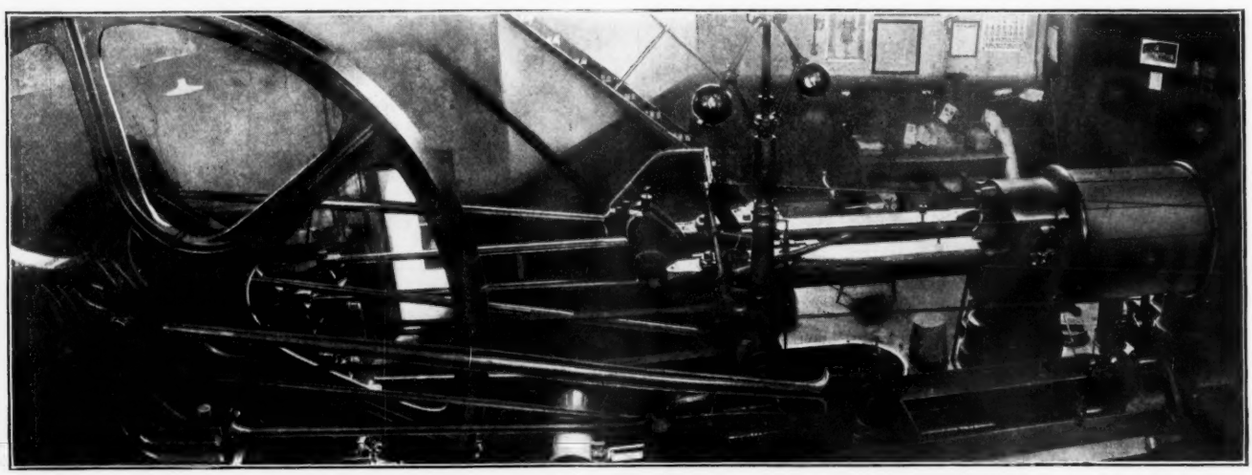


FIG. 1. CORLISS CROSS-COMPOUND PUMPING ENGINE AT EASTON, PENN.

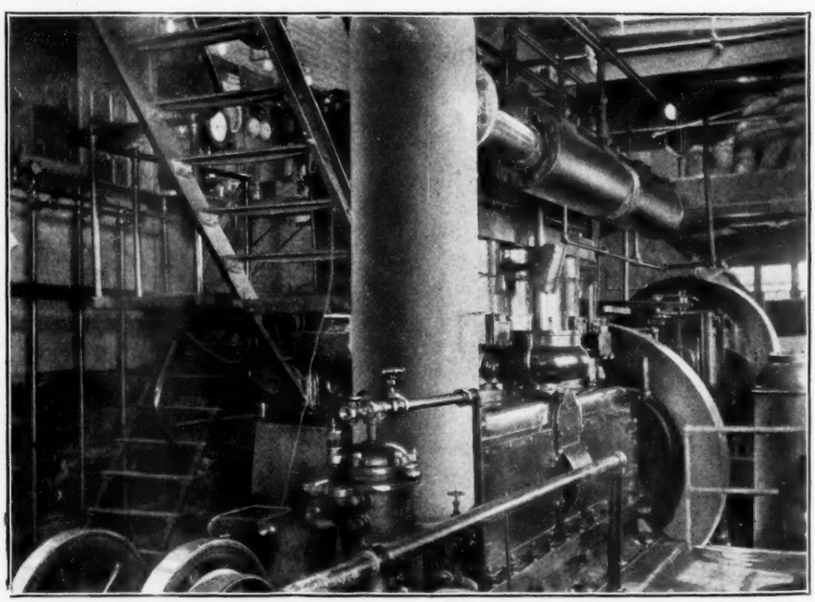


FIG. 2. GAS ENGINE AND PUMP FROM THE PRODUCER END

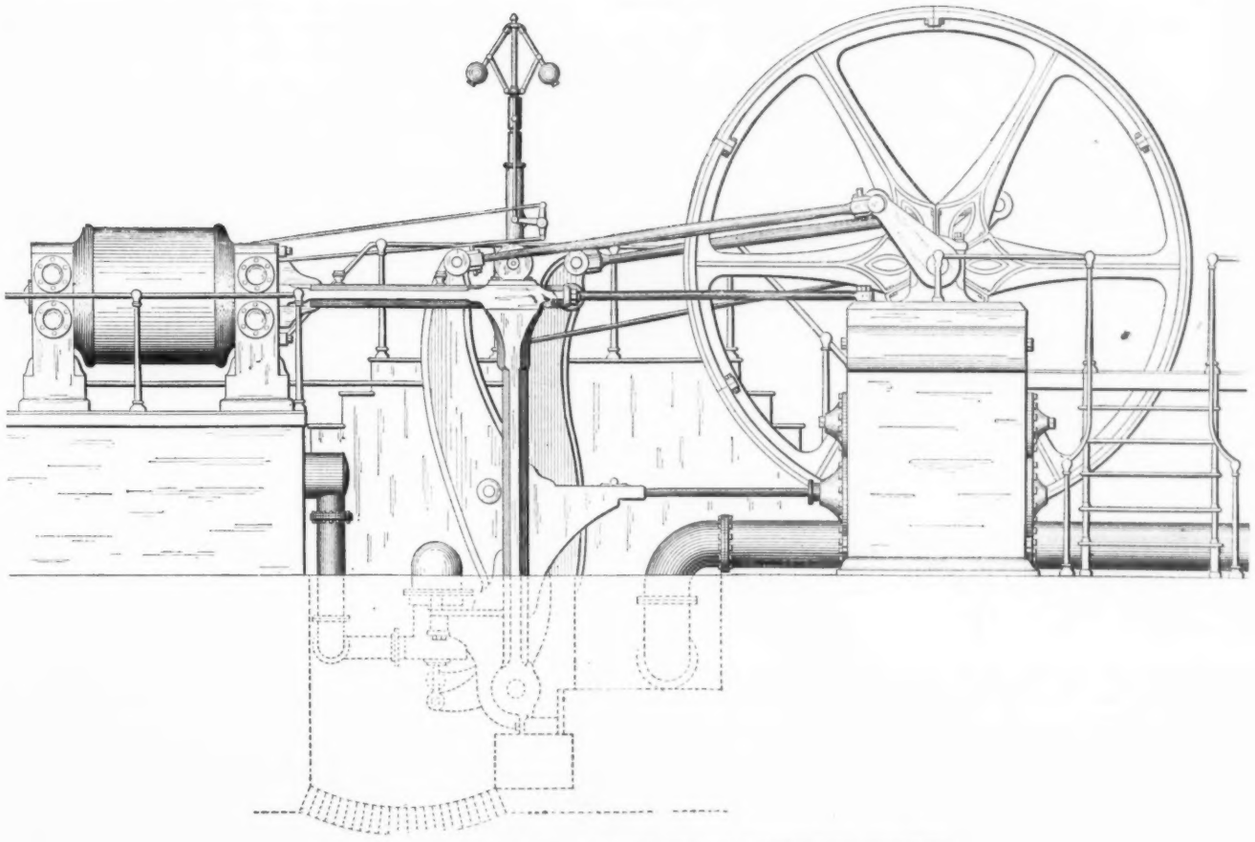


FIG. 3. ELEVATION OF CORLISS FIRST COMPOUND ENGINE

ft-lb., 72-hr. run 107,000,000 ft.-lb.; the average duty was between 90,000,000 and 100,000,000 ft.-lb. per 12-hr. run. The speed in its present plant is 62 r.p.m. and the head is 280 ft.

Although the pump has had its cylinder rebored but once in its 35 years of active service, the valve seats have never been rebored. The original boilers that supplied it with steam have long since been discarded, and the boilers that now serve the pump at 125 lb. pressure are being replaced with water-tube boilers. The old pump will be removed, and a turbine-driven centrifugal pump will take its place. Superintendent R. P. Rader, who has been with the Lehigh Water Co. since 1875, or 41 years, has had charge of the pump since its installation. During the past 1½ years the old Corliss pump and the two boilers have been held as reserve units, the water being pumped by a producer-gas pumping plant. Figs. 2 and 4 show this installation. The gas producer, engine and pump are all on the same level and are in a one-room extension of the building. The four-cylinder 16x20-in. engine is of 300-hp. capacity and runs at 225 r.p.m. Between the engine and pump gearing is a flexible coupling, and the shaft extending from it is fitted with a pinion gear that meshes with a larger one that drives the triplex pump at 48 r.p.m. At this speed the pump has a capacity of 4,500,000 gal. of water per 24 hr. working against a head of 280 ft.

Although the old Corliss pump is still in good condition, it has served its days of usefulness in its present plant, the demand for more water necessitating the putting in of a greater-capacity pumping unit. That it will be thrown out on the scrap pile is doubtful, for although it has seen 35 years of active service, it is good for many more and will probably be put to work in some smaller pumping plant of less capacity.

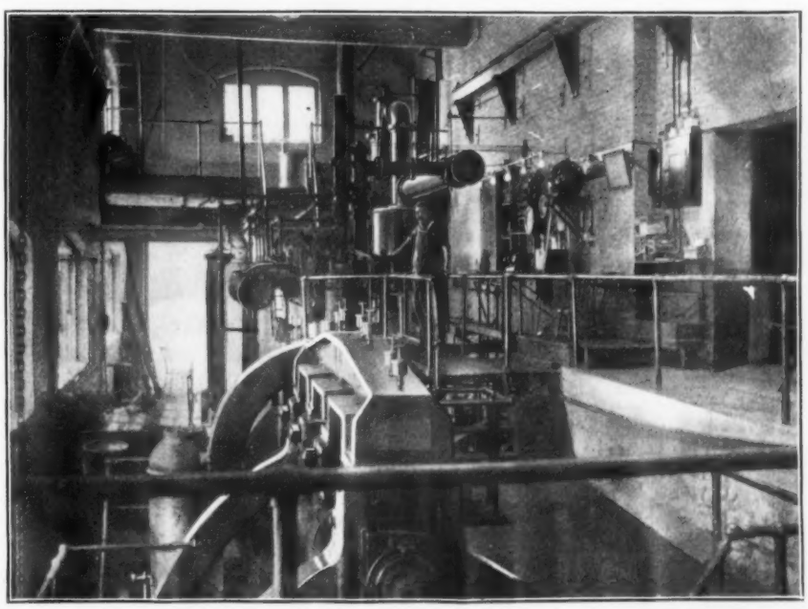


FIG. 4. GAS PRODUCER-GAS ENGINE DRIVEN PUMP FROM THE PUMP END

Suggestions on Soldering

By R. L. Hervey

Engineers sometimes have occasion to do small jobs of soldering, and the following hints may help out:

In soldering tinned surfaces no particular care is necessary, as the solder will adhere easily when the surfaces are clean, but in the case of brass and other metals that are not tinned, a flux or acid solution is needed to make the surfaces clean so that the solder will take hold. Cleanliness is necessary, for the solder will not adhere to a surface that is dirty or greasy, even though it may appear perfectly clean. Oil or grease may be removed with such agencies as gasoline, but if the surfaces are oxidized, filing or scraping them must sometimes be resorted to, after which they should be thoroughly covered with solder before attempting to join them; they are then soldered like tin.

When soldering electrical apparatus, nothing but a rosin flux should be used, as it is free from injurious acids and is a fair insulator. It can be applied in lump or powdered form, or as a paste by dissolving it in alcohol. There are several handy combinations of rosin-solder on the market, such as a slender tube of solder filled with rosin so that in use the flux is applied as the solder is melted and applied. Prepared soldering pastes and fluids may be bought, all of which are more or less satisfactory and convenient to use. A strong acid solution can be made by dissolving scraps of sheet zinc in muriatic acid, a little at a time to avoid generating too much heat, taking care not to inhale the acid fumes. The zinc should be clean and cut in small strips and the fluid kept in an air-tight glass or earthen vessel after it has cooled. For reasonably clean surfaces dilute with about an equal amount of pure soft water, but for galvanized iron, etc., use full strength, and apply with a rag or small brush. Where a flux containing an acid or chloride of zinc has been used, the surface should be thoroughly washed and dried to stop the acid action, after the job is done. For hard-soldering or brazing, borax is the best flux, as it dissolves any oxide that may exist on the surface of the metal and protects it from the air, thus allowing the solder to come in actual contact with the metal.

When using the ordinary soft solder for brass, copper or steel, the surfaces to be joined together, should be first tinned; that is, be given a thin coating of solder. This may be done with a torch by heating quickly but just enough to cause the solder to flow over the surfaces when the flux is applied. If a soldering iron (copper) is used, flux is first applied, then with as much molten solder on the iron as it will hold, the hot iron is rubbed over the surfaces until they are well covered. The surfaces are then pressed or clamped together and again heated and more flux and solder used till the opening is well filled. Care must be exercised to make sure that the solder flows over and is not simply pushed over the surface or into the joint. Any surplus solder should be wiped off with a dry rag before it hardens.

With the use of hard solder a higher temperature is required than can be obtained with a soldering iron, therefore a blowtorch or gas blast must be used. When making a joint with solder, it is necessary that the solder have a lower melting point than the pieces to be joined together. Absolute cleanliness is as important with hard solder as with soft. Instead of tinning or coating the surfaces separately, the parts should be clamped together or bound with iron or steel wire. After the pieces have reached a temperature high enough to melt the solder, the borax flux is applied with the aid of a special ladle, then the solder is added and worked into the joint with a small iron rod.

The following table giving the composition and melting points of different solders will be found useful:

Name	Composition	Flux	Melting Point, Deg. F.
Plumber's coarse solder	Tin 1, lead 3	R	800
Plumber's sealed solder	Tin 1, lead 3	R	440
Plumber's fine solder.	Tin 1, lead 2	R	370
Tinner's solder	Tin 1½, lead 1	R or Z	334
Tinner's fine solder....	Tin 2, lead 1	R or Z	340
Hard solder for copper, brass and iron.....	Copper 2, lead 1	B	
Hard solder for copper, brass and iron.....	Brass 5, lead 1	B	
Silver solder for silver, brass and iron.....	Silver 1, brass 1	B	
Silver solder for steel.	Silver 19, copper 1, brass 1	B	
Bismuth solder.....	Lead 4, tin 4, bismuth 1	R or Z	320
Bismuth	Lead 3, tin 5, bismuth 3	R or Z	202

Abbreviations: R, rosin; B, borax; Z, chloride of Zinc.

Advantage may be taken of the difference in the melting points of the various solders when making two or more joints in one piece of metal. Thus, if a joint be made with a fine tinner's solder, there will be no danger of loosening it in making a joint near it with soft solder. Soft solder does not make a malleable joint. To join brass or iron so as to make a strong malleable joint a hard solder should be used; a silver solder does very well.

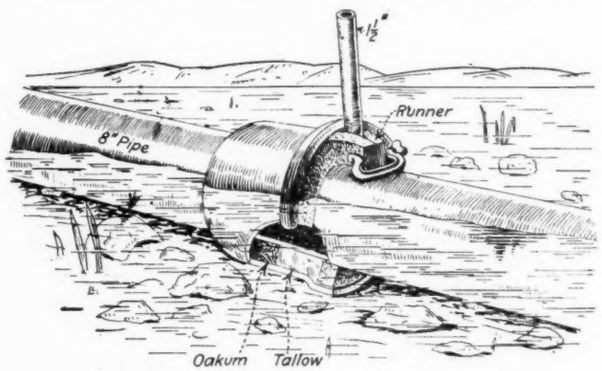
Welding with the acetylene and oxygen flame or electric arc is just an advanced step along the line of hard-soldering, using a high temperature so that the two bodies, whether of brass or steel, are fused and united with a special flux and metal.

Pouring Lead Joint Under Water

By Thomas Sheehan

The illustration shows a lead joint on an 8-in. pipe line. This joint was made under water, as we could not get all the water out of the river bed.

The oakum was first packed in, then the space for lead was packed with tallow. As the hot lead was poured in



LEAD POURED IN WET PIPE JOINT

through the 1½-in. pipe, it forced the tallow out. We did not have good luck at first, but after a couple of trials succeeded in pouring a good joint.

The Furnace Temperature must be kept high enough to burn the gases, but must not be so high as to melt the ash.

Editorials

Good Showing of Canadian Municipal Enterprise

Friends of municipal ownership will indeed be gratified by the report of the Toronto Hydro-Electric System, just issued for the year 1915. This system, it will be recalled, is one of many supplied with Niagara power by the Hydro-Electric Power Commission of Ontario, which has done such creditable work in extending the use of cheap electricity throughout the province of Ontario.

The electric rates in Toronto are low, averaging less than three cents per kilowatt-hour for residence lighting, two and one-quarter cents for commercial lighting and less than one cent for commercial power. These rates are comparable with those of the Cleveland municipal plant, perhaps the most conspicuous municipal undertaking of its kind in this country. The figures quoted represent rates thirteen to twenty-eight per cent. below those of the preceding year; yet, in spite of this reduction, the gross receipts showed an increase of nearly eight per cent. Practically one-third of the output was for public service and two-thirds went to private consumers.

In the matter of fixed charges, which amount to thirty-seven and a half per cent. of the gross income, the practice has been to include interest on debentures, a sinking fund and depreciation. Thus replacements are provided for out of revenues, and at the expiration of the term for which the bonds are issued the equipment will have paid for itself and represent an asset to the city. New construction is provided out of additional bond issues, and it is planned for the future to make these serial in form and limited to the probable life of the equipment. This will do away with the necessity of continuing to make payments on property no longer useful—a practice all too common in many cities; it will also tend to keep down the bonded debt.

The net profit of the Toronto system for the year was small—in fact, only about three thousand dollars. However, having taken care of all legitimate charges and provided a reserve for contingencies, the small profit may be regarded as an indication of good management; for the city is not in the business to make profits at the expense of its citizens, but rather to serve the public as cheaply as possible without being an expense to the taxpayer.

Thirty-Five Years of Service

On another page of this issue is an article relating to the first compound pumping engine built by George H. Corliss. After thirty-five years of almost continuous service day and night and having the cylinders rebored but once, this engine is still in use as a stand-by unit and is in good operating condition. It is, however, about to be taken out to make room for a unit of larger capacity.

It is not uncommon to find engines that have been in service for similar long periods, and one is led to ponder over the fact that some of the modern units are placed in the hands of the repair gang within a year or so of their installation. Why?

Reciprocating-engine practice has not changed materially since the days of James Watt, except in the matter of refinement of parts and of valve gear, and the principle of operation still holds good. It is true that the service required of steam engines of today is more severe than that of former years, but if the unit is designed for the work to which it is put, the active life should be as long as the engines that were built for less severe service.

Naturally, the care that is taken of a machine contributes largely to its days of service. The most perfectly designed engine built can be ruined in a short time by a careless or ignorant engineer. On the other hand, a poorly designed and cheaply constructed engine in the hands of a skillful engineer can be made to give fairly good service, except perhaps in the matter of economy.

In the days of the past, engineers, as a rule, were not the skillful workmen that are now found in charge of steam machinery, and consequently they were not capable of keeping their engines in the same good conditions that the modern engineer is supposed to do. Notwithstanding this, the old-time engines have demonstrated that they were capable of doing their work for longer periods and with less repairs than are those of modern times.

One is naturally led to wonder, notwithstanding the better foundry facilities for making castings and the more modern machine-shop tools, if the material and workmanship put into the engines of former years were not better than those of today. Some old engine castings recently examined, after being broken up as scrap iron, showed the absence of blow-holes, and the texture of the metal was all that could be desired. On modern engines it is common to find the bore of a cylinder showing a coarse grain and innumerable small cavities in the metal; this gives one the impression that a poor grade of iron was used and one that had not been thoroughly prepared before the casting was made. Many times the machinery is far from representing first-class workmanship.

Probably competition is responsible for these conditions, but it would appear from the fame and records of the old builders that a well-designed, well-built engine made of the best material would be a paying investment in the long run.

Anyone familiar with the products of Corliss knows that they stood for economy in operation and for the best of workmanship and material. There are engines on the market today the mentioning of which among engineers is considered a joke. The pity is that these engines have many excellent features of design, but the material and workmanship are such that one experience with them is enough.

The removal of this old Corliss pumping engine is simply one more step in the progress of time. It has done all and probably more than its designer intended that it should do. The main thing to be regretted is that there are not more engines being built that will have such an enviable record.

Shall Ammonia Explosions Continue Unheeded?

How many more such accidents as occurred at Newark the other day will it require to awaken the public to the necessity of adequate legislation covering the construction and operation of refrigeration systems? Here the toll was seven lives and several seriously injured. Indeed, ammonia explosions are becoming a close second to boiler explosions.

Unfortunately those best able to explain what happened are dead, but information gleaned from survivors and from an inspection after the accident points to the absence of a safety valve, although this has been disputed by some connected with the installation. Whichever version is correct, one of three things is certain: There either was no safety valve; it did not work when the pressure built up, owing to the stopping of the circulating water; or the welded seam in the receiver failed at a pressure below the safe working pressure of the system.

This failure of the receiver seam again brings up a consideration of autogenous welding for vessels under pressure. This has long been a debatable subject in boiler practice and the consensus of opinion thus far has been unfavorable; in fact, some states have made specific provisions against these joints. Not that such joints cannot be made as strong as the solid plate, but the uncertainty lies in the human element; that is, in the skill of the workman making the weld. Moreover, there is practically no way of establishing the soundness of such a weld.

A few states and municipalities already have laws pertaining to ammonia compression systems. That such an accident would have been impossible under these regulations is perhaps assuming too much, but the chances would have been greatly lessened.

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Electrical Controllers

There is not an industry in this country that has not been influenced by the introduction of the electric motor. One of the chief reasons why the electric motor has been able to displace, to a very large extent, other means for driving industrial machinery is the fact that it is more flexible. An important factor in the application of electric motors to the various drives is the controlling device. It is not enough that the motor be of the right design for the duty it is to perform, but it must also be equipped with the proper controlling apparatus. No small amount of attention should be given this feature when choosing an electric drive, for upon the selection of the proper controller may depend the success or failure of the installation. For certain conditions on small drives a simple hand-starting device may be sufficient, especially when the motor is started and stopped only once or twice each day; but even for this class of service automatic starters are being used to a considerable extent. When the motor is large and is started, stopped and reversed many times a day with all sorts of speed variation and dynamic braking, the control device becomes complicated, and probably needs be so.

For the automatic acceleration of electric motors three means of control are in vogue—namely, counter electromotive force, current limit and time element. All three methods have found a wide use, each having its own particular advantages and disadvantages for certain service conditions.

Before an operating engineer or electrician can properly care for and adjust the various parts so that they will perform their functions in the proper sequence, also locate and repair trouble on a controlling device, he must have an intelligent working knowledge of its principles of operation. This does not necessarily mean that he must be familiar with all the different styles of controllers on the market, for such a task would be almost impossible. However, when one has an intelligent understanding of the general principles involved in the various electric-motor controllers, it is usually an easy matter to make the proper adjustments expeditiously and locate trouble on almost any piece of industrial-control apparatus.

Elsewhere in this issue is the first of a series of practical talks on controllers. These articles will be representative of the most popular types of industrial controllers on the market today and will be written in a way that will explain the principles of operation, how to trace the various circuits and each function performed by the controller. The limitations of each device will be pointed out and also the way to locate some of the most common troubles that may be experienced in operation. This presentation of the subject should prove to be not only of great interest to readers, but also a valuable reference to be preserved.

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In engineering matters the big things are attempted and accomplished on the basis of conviction and not simply guesswork, belief or opinion. Conviction by its definition implies study, investigation and deep thorough analysis, all of which have crystallized into a conviction, and it is the thing that takes hold, as a result, following the stages of guessing, theorizing and opinions. It is well to take stock occasionally, to classify and find out how many of our items of information fall under the various heads—conviction, opinion or guess—for there is a vast difference in the value and utility of this stock as well as of any other material in the process toward a finished product.

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"The United States is decidedly behind other great producing countries in the consideration given to her foreign customers."—H. F. L. Orcutt in *London Engineering*. As manufacturers of power-plant equipment have learned. But then, one must remember that nations as well as individuals must be stimulated to action. A young and prosperous nation with resources at home bewildering in their volume and variety cannot be expected to develop energetically in distant channels until those near-by make the going hard.

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A bonus to firemen for excelling the ordinary performance of their work is not a gift, but a fraction of the saving that the owner realizes through the fireman's skill in making good use of the facilities which the owner provides.

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Some men take upon themselves very trying missions in this life; but the one we would leave until the last is that of convincing all engineers that the crosshead stops on dead-center.

Correspondence

What Blisters the Boilers?

Replying to George F. Wright in the Aug. 1 issue as to "What Blisters the Boilers?" there are several causes, any one of which may have been the source of the trouble. Defective boiler plates may be the result of impurities accidentally rolled in, causing local separations or laminations in the surface layer of the plate. When such a plate is used in the shell or flues, the layer exposed to intense heat expands more than the inner layers, thus causing buckling and further separation, which gives rise to a bulge or blister, beginning at a small local bulge and gradually extending over a larger surface as in the case of the correspondent's boiler. Furthermore, if such defective plates are exposed to furnaces, overheating is likely to occur, produced by the nonconducting layer of steam or air that may exist between the several laminations in the plate.

Where a sufficiently thick deposit of scale or foreign matter has settled upon the inner surface of the furnace sheet where it is exposed to particularly high heat, a blister or bagged sheet may readily form from overheating. This would be especially the case where the scale had cracked enough to separate from the inner surface of the plate and thus allow a layer of superheated steam to lodge between the scale and the plate. Steam, being a good nonconductor, would readily cause overheating of the plate at that point, which might easily result in a blister or bulge.

Oily feed water is a further and frequent source of blistering and bulging—not only in furnace plates, but also in the tubes of water-tube boilers, where such tubes are in direct contact with the hottest gases from the furnace and are also exposed to direct radiation from the incandescent fuel underneath. Even the slightest film of oil alone is sufficient to cause bulges and burnt-out water tubes or boiler plates.

Where oil is present in the feed water, it not only causes overheating of furnace plates directly over the fire by reason of the nonconducting qualities of only a slight film of oil, but such oil may partly combine with the mineral matter or loosely floating impurities in the feed water, so that when a sufficient amount of such a highly nonconducting combination has, by reason of the circulating currents of water, been deposited in any particular point on the lower sheet of the boiler, such point is most likely to suffer from overheating and consequent blistering, if in the vicinity of the hotter parts of the furnace. Inasmuch as the blisters in the correspondent's three boilers have always occurred in the same spots and the boilers are of the same size and type and the conditions in each boiler the same, the circulation of the water is in all probability also the same. This would easily account for the inner deposits always having been found in the same spot and where in consequence the blisters were formed.

It would have been of further interest had the nature of the feed water and of the particular deposits or scale found over the blistered portion of these boilers been mentioned—whether such water was very hard, containing a large amount of mineral matter, and whether any return condensate containing more or less lubricating oil from the engine had been added to the boiler as feed water.

In the former case the proper chemical treatment for softening the water would be most likely to remove the trouble.

If, however, the return condensate, containing only a trace of oil and indicated by a hazy or milky appearance, is used as feed water, the only remedy is to remove such oil from the water before admitting it into the boiler. It is not only necessary to remove the coarse or rough floating oil rising to the surface, by means of any of the well-known methods of skimming or rough-grease extraction, but the hazy or emulsified oil should also be thoroughly removed, preferably without chemical treatment or coagulation. Whichever filter or process is used for removing such cloudy or emulsified oil from the return condensate, absolute clearness of the resulting water should be insisted upon by the purchaser.

Judging from the correspondent's statement that his boilers were free from "excessive scale" and that the blisters always occurred in the same place in each of the three boilers, laminations or faulty composition of the plates does not appear to be the direct source of the trouble, but rather faulty circulation causing impurities in the feed water to collect and pile up where the blisters are formed, or a combination of oil in the feed water with the scale, appears to be the most likely origin of the blisters.

A. E. KRAUSE.

Jersey City, N. J.

The blistering of the three boilers mentioned in the Aug. 1 issue may or may not have been caused by scale. Many boilers blister at this point, and in some cases there is not enough scale to cause the trouble. I was once called to unravel trouble of a similar nature. I instructed the engineer to prepare the boiler for filling, intimating that I wanted to observe its actions while raising steam. I watched the boiler attendant preparing the manhole plate at the front end below the tubes. The gasket was cleaned thoroughly and a liberal supply of oil poured into the groove provided for the gasket. This was the source of the whole trouble. The manhole plate was placed in the boiler horizontally and then turned to a vertical position, allowing a large portion of the oil thus introduced to run down onto the bottom of the boiler shell.

This is a practice that should not be tolerated by the engineer. A small brush should be provided and the men instructed as to the danger of using an excessive quantity of oil.

Trouble of the nature mentioned is not always easily traced, as the oil may have evaporated by the time the boiler is cooled down ready for inspection. There is no disputing that scale will settle at this point, especially when the sheet is distorted, and this distortion will appear

to have been caused by scale, when oil was the original cause of the trouble. W. ELKINS.

Evansville, Ind.

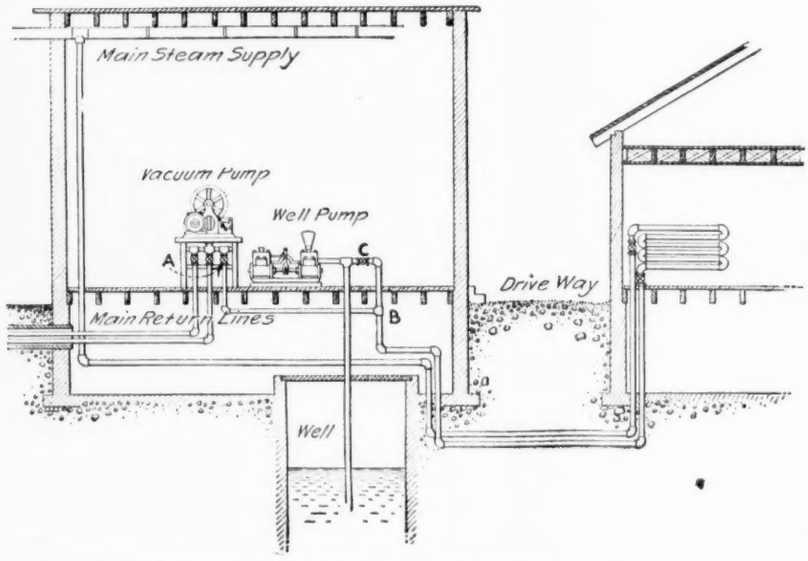
I believe the cause is scale that originally collects on top of the flues and is then cast off. The bottoms of the boilers may be perfectly cleaned where they are easily reached, but no doubt a great quantity of scale could be found on top of the flues. This scale becomes dry and hard when the boiler is cooled down to be cleaned, but when it is refilled it becomes soft and a portion falls on the bottom of the boiler and by feeding through the blowoff this muddy water flows toward the front of boiler and settles there and may cause it to bag inside of 24 hours. It will probably be only a matter of a short time before the boilers will need retubing.

I believe about the only successful remedy is the one I have found through actual experience, and this is as follows: Change the feed line to the front end of the boiler, use no boiler compounds and blow off every 24 hours or oftener if convenient, with 40 to 60 lb. pressure.

Eskdale, W. Va. J. W. MATHENY.

Vacuum Heating Kink

In a power plant in connection with which there was a vacuum heating system the following condition was found: The main part of the heating system was laid out in such a manner that all the condensation would return to the vacuum pump, and to keep up a good circulation a 6-in. vacuum was sufficient. There was, however, a small connection underground to a storehouse that was lower than any other part of the system. This left a pocket in both supply and return that would gather condensation when the circulation was allowed to stop, and it required a 12-in. vacuum at the pump to start it again. The return pipe from the storehouse was connected in such a way that it would get hot from the other lines, and one could not tell by its temperature whether there was a circulation or not, so the whole thing was unsatisfactory, particularly during freezing weather.



HEATING RETURN CONNECTED TO WELL PUMP SUCTION

It was undesirable to increase the vacuum permanently, and the piping could not be laid at a suitable level on account of a driveway between the buildings. The difficulty was finally overcome by connecting a ½-in. pipe from the return line *B* to the suction of a small pump that was kept in continuous operation drawing water from a well of sufficient depth to keep the required vacuum on the return line at all times. Valve *A* was kept closed, and *C* was regulated to suit the requirements. This gave satisfactory results, and the expense for the change was slight. LEON ROUNDY.

North Billerica, Mass.

Calculating the Quantity of Ammonia Needed

In the June 13 issue is an article on "Calculating the Quantity of Ammonia Needed," by Charles H. Bromley. His method of estimating the inoperative portion of the charge is correct. He has filled the liquid lines with liquid, with a reserve quantity for the receiver, and filled the suction lines and expansion coils with gas at suction pressure, but little or no refrigeration would be obtained from these sources.

The part of the ammonia charge that produces the greatest proportion of refrigeration is the liquid that is boiling in the expansion coils or, in other words, is absorbing its heat of vaporization from the coolers in which the coils are placed.

The amount of ammonia required for this purpose will in most cases be several times the inert liquid and gas as estimated by Mr. Bromley. The exact amount will be determined by the following conditions: (1) Wet or dry compression; (2) rate of heat transfer between the ammonia and the cooler; (3) top or bottom feed to coils. For instance, if the coils are bottom-fed and the compressor is to be run with cool discharge pipes, there will be required sufficient liquid in the coils to fill them to overflowing with boiling liquid. If the rate of heat transfer is high—that is, if the liquid is boiling rapidly—less liquid will be required than in case the rate of transfer is low and the liquid does not boil so violently. This of course is only theoretical, though important when the liquid disappears from the receiver, and no one knows where it goes. Look to the large coils that are not doing much work, for it will usually be found there.

In the system of which I am in charge there is over 20,000 lin.ft. of 2-in. pipe, or its equivalent. The compressor is a 125-ton machine. From the rules given by Mr. Bromley the charge would be about 1,000 lb. or less. Since I have been in charge here, we have put into the system 9,000 lb. of ammonia. There was a small amount in; how much I do not know. Neglecting the original charge, there is in the system probably all the 9,000 lb. which I have added. The volume in 20,000 ft. of 2-in. standard pipe is $20{,}000 \times \frac{2.33}{100} = 466$ cu.ft.

Subtracting 1,000 lb. for the inert charge from the 9,000 lb. total gives a true working charge of 8,000 lb. in a system of coils containing only 466 cu.ft., which gives about 17 lb. of ammonia per cubic foot of expansion coil.

Needless to say, our expansion coils are mostly of the bottom-feed type and we have a wet compression machine, though we run it as hot as possible without warming the rod.

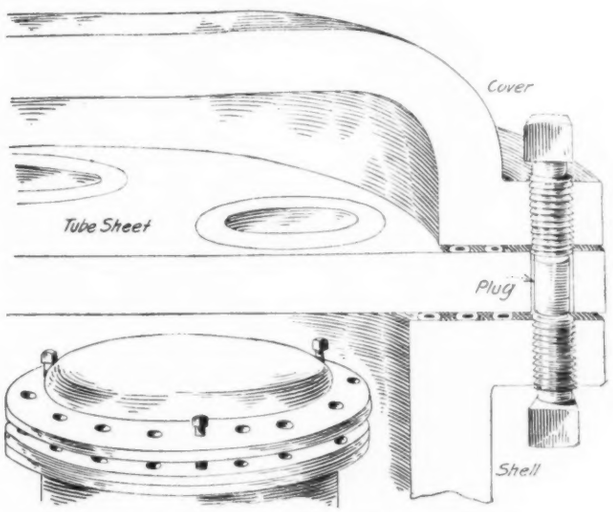
It is to be inferred from the foregoing that the expansion coils contain from 30 to 50 per cent. of their volume of solid liquid, which, as it boils, practically fills the total volume of the expansion coils.

This rule may be far from correct if applied to other plants, but it is the only data I have and is here given for what it is worth. C. E. MOULSON.

Mason City, Iowa.

To Raise Heater Cover

The illustration shows a handy way to raise the cover and tube sheet of a closed heater for the purpose of renewing the gasket joint. Tap out as many of the



THREE BOLT HOLES TAPPED FOR LIFTING SCREWS

bolt holes as may be necessary—three equally spaced will probably be enough—and insert setscrews, as shown. A plug in the tube sheet will give a "heel" for the setscrews to push against. The job can then be done in close quarters. B. NOLAN.

Boston, Mass.

Safety Head a Discharge Valve

In the July 18 issue of *Power* an article called "Troubles and Care of Ammonia Compressor Valves" says that the safety head on this compressor is not a discharge valve and must not be allowed to act as such. I have the same kind of compressor, a Frick 7x10½-in. two-cylinder machine, and the safety head acts as a discharge valve.

Do I correctly understand Mr. Solomon? I see no way that a valve can be put in this particular head.

The only trouble I have had with this compressor has been caused by the discharge valve (or safety head) getting gummed and stuck, not allowing it to seat freely. Oiling with fresh oil has always so far cured this trouble. During the recent hot weather I have had to speed up rather more than seems necessary. I wonder if the cylinder does not need facing with a boring bar, or would a different discharge valve be beneficial?

Boston, Mass. H. A. GREEN.

Viscosity in Cylinder Oils*

As I understand the discussion pertaining to viscosity in cylinder oils in your columns, Mr. Carpenter claimed that the use of the viscosity test as an argument of quality on the part of the oil salesman was a humbug. When he made the statement, instead of standing flatly upon his reputation as being sufficient authority for its truth, he offered to debate the question with all comers, for the benefit of the readers of *Power*, by which I take it is meant all the readers, or the average engineer, the man who requires light on this subject most. It was not to be for the benefit of the chemist or for those engineers who have access to laboratories and chemists, but for the engineer upon whom the employer depends to see that the best cylinder oil is used and that it is purchased at a reasonable price. It seems as if Mr. Carpenter alone gives facts and proofs, while the others very largely give opinions.

Upon reading J. Motion's references to the article on "Fractional Distillation of Cylinder Oils," by J. G. O'Neill in the issue of July 18, I obtained a copy of that issue and studied Mr. O'Neill's article. While it is very interesting, I must confess that a great deal of it is "over my head" and that I cannot find in it a single line that convinces me that you can judge the quality of a cylinder oil by its viscosity.

I became so impressed by the constant reference to the viscosity test by sellers of oils, that I bought myself a viscosimeter. I was using a well-known cylinder oil, and it seemed to be doing its work as it should. But I had paid my good money for the viscosimeter and proposed to get the price back. I obtained samples of the various cylinder oils that had been offered me and found that the oil I was using was the lowest of the lot in viscosity-test and almost the highest in price. I concluded that at last I "had one on" our oil man and requisitioned the purchasing department to buy me a barrel of the highest viscosity-test oil. The result was more groaning and less lubrication than it had ever been my misfortune to witness in a power plant. Every one of the three engines, as well as the pumps, acted alike. I went back to the less viscous oil.

Feeling that I had paid my money for a viscosimeter with no other benefit than to make a fool of myself, I hunted around for an even less viscous oil than I was using (and it was difficult to find), and I tried a barrel of that oil. While the groaning was not perceptible, it did require so much more of the less viscous oil to keep things quiet that it was self-evident that the oil I was using was better.

Mr. Carpenter's statement, "If viscosity is viscosity, it makes no difference how you get the viscosity," is brushed aside by the other experts as if it were unworthy of reply—ridiculous, as it were. [Mr. Carpenter's statement was:

*Discussion in "Power" for Apr. 11, May 16 and 30, June 20, July 18, Aug. 15.

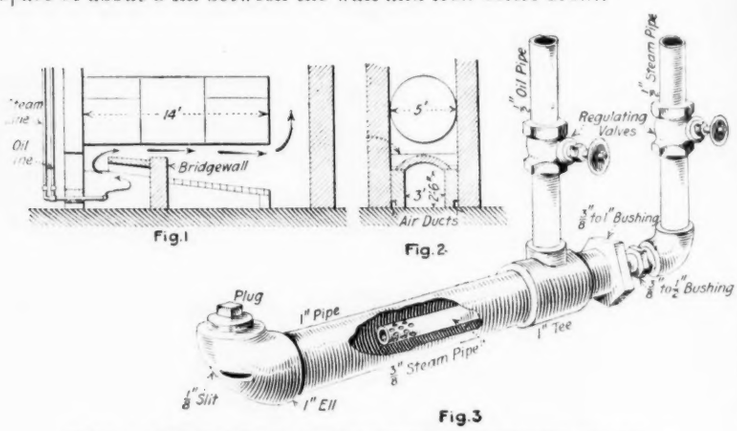
"If viscosity is viscosity, what difference does it make how the oil gets it?"—Editor.] Let them show just how it is that Mr. Carpenter's statement is ridiculous and how we engineers are going to tell how the oil man obtains his viscosity if the viscosimeter does not determine it. This discussion is one of the most interesting that has occurred in *Power;* it is an opportunity that the ordinary engineer has wanted for years, to learn more about cylinder oils, and I hope the discussion will not close. Certainly up to date the evidence is all in favor of Mr. Carpenter's statement that "viscosity" as used to sell oils is a humbug. I am certain that most *Power* readers agree with him. I think more readers who have had experiences like mine should give *Power* the benefit of them, for it was a good thought to start this discussion.

Philadelphia, Penn. RICHARD J. DIAMOND.

Oil-Burning Boiler Furnace

Readers of *Power* may be interested in the description of an oil-burning furnace for return-tubular boilers with which I have had excellent results.

Figs. 1 and 2 show the construction as applied to an 80-hp. boiler. The arch with supporting walls and the absence of grates constitute the only change from the ordinary furnace. A wall should be built across the furnace to the dead plate under the fire-doors, leaving a space of about 8 in. between the wall and iron boiler front.



FIGS. 1 AND 2 SHOW APPLICATION OF BURNER IN FIG. 3

From this open space the air ducts built in the side walls, as shown, should lead to the lower corners of the furnace against the bridge-wall. The air ducts for this size of furnace should have a cross-sectional area of about 40 in. In the front wall there should be an opening about 8-in. square through which to insert the burner and for the admission of additional air; also to observe the flame, that it is not leaving a deposit of carbon on the walls of the furnace. With a properly constructed burner and correct regulation of air, steam and oil, which is easy, there will be no deposit in the furnace with any grade of fuel oil and no smoke or soot.

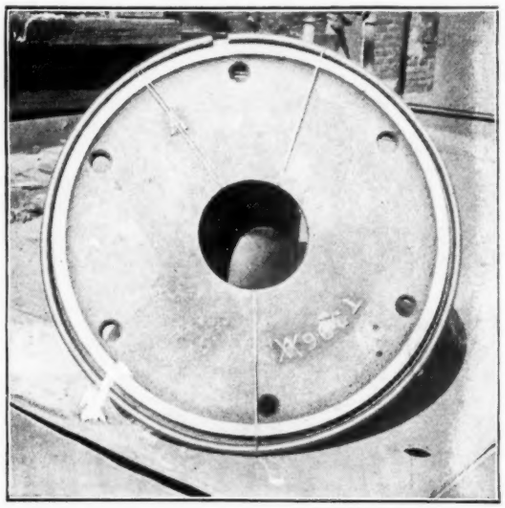
The fire-door should be bricked up and a peep-hole about 3-in. square on a level with the bottom of the arch should be made between the doors to observe the condition of the fire. The arch should be 2 or 3 in. higher at the front than at the back, and for this size of boiler the top of the bridge-wall and the highest point of the arch is 12 in. from the boiler shell.

Fig. 3 shows the home-made burner I use and find to be equal to any on the market. The burner should extend into the furnace from 8 to 12 in., and the end of the inner (⅜-in.) steam pipe should not come nearer than 12 in. to the burner end, and probably a better mixture is obtained if a number of ⅛-in. holes are drilled near the end of this ⅜-in. pipe. The slit in the burner end should be ⅛ in. wide and so made that it will project the fuel mixture to the back of the furnace under the arch. If the slit is cut too long, some of the fuel will be thrown on the side walls not covered by the arch and a carbon deposit will be formed at these points that will require considerable labor to remove. The burner should be about 6 in. from the floor of the furnace.

Ash Fork, Ariz. W. G. CAMP.

Getting Expander Ring in Place

The writer was on a repair job renewing the leathers in a number of air hoists and jacks in a local foundry recently. Considerable difficulty was experienced with the expander ring of the first jack; on account of the stiffness of the ring and the location of the piston head it was hard to coax the ring into the leather and get it to stay there until the follower plate could be drawn up. The illustration shows how the rings were compressed and tied into the ring groove of the follower with medium-gage copper wire. This held it entirely free from the leather, and the follower was slipped into place over the studs without trouble. When the nuts were drawn down a little the wire was loosened and pulled out, allowing the ring to exert its pressure against the leather, forcing it against the walls of the cylinder. On the expander rings of hoists located in inaccessible places, as many of them are, this kink was found to be a time saver.



EXPANDER RING TIED TO FOLLOWER PLATE

Missouri Valley, Iowa. F. W. BENTLEY, JR.

Lignite Fields of Northwestern South Dakota—Few people think of South Dakota as containing much fuel and therefore many may be surprised to know that in Perkins and Harding Counties, in that state, there are more than 1,000,000,000 tons of coal. This estimate is given in Bulletin 627 of the United States Geological Survey, just published, and covers lignite in beds more than 2 ft. 6 in. thick. At present this lignite is mined for local domestic use, and as fuel for steam-plow equipments and for the making of briquettes it proves a very superior fuel.

Inquiries of General Interest

Effect of Addition of Lap to Valve—How does the addition of lap affect the operation of an engine slide valve that is moved by an eccentric? W. R. B.

The addition of lap causes the valve to open later and close earlier in the stroke. Hence with addition of lap, to preserve the lead the eccentric must be set farther ahead on the shaft, and this will cause the valve to close still earlier in the stroke.

Reversing Rotation of Synchronous Motor—How is the direction of rotation of a synchronous motor reversed? T. A.

The direction of rotation of a polyphase synchronous motor is reversed the same as an induction motor; namely, by interchanging the leads of one phase. In the single-phase machine the direction of the starting device will have to be reversed, as a single-phase synchronous motor will run in whichever direction it is started.

Equalizing Load in Corliss-Engine Cylinder—If one end of a Corliss-engine cylinder is doing 40 i.hp. and the other 60 i.hp., how can the engine be adjusted to equalize the load? W. M.

The load can be equalized by adjusting the length of the governor reach rods to cause earlier cutoff in the end having the higher m.e.p. and longer cutoff in the other end of the cylinder. The desired equalization can usually be obtained by adjusting one of the governor reach rods.

Groaning of Engine—What causes grunting or groaning in the cylinder of an engine? W. S. B.

Groaning is usually attributable to want of better lubrication of the piston or piston rod and frequently occurs in cylinders from the use of wet steam that sweeps the lubricant from the rubbing surfaces. In some engines, groaning vibrations continue even with good distribution of lubricating materials, but in the majority of cases the noise can be stopped by the use of heavier lubricants or cylinder oils of higher flash point.

Size of Cooling Pond—What size of open pond will be required for cooling the condensing water of a 2,000-kw. turbine plant? G. W. M.

For average conditions and without spraying, about 160 sq.ft. of pond surface would be required per kilowatt and for a 2,000-kw. plant 320,000 sq.ft., or about 7¼ acres. The depth of the water should be about 3 ft. There would be a loss by evaporation of 5,000 to 10,000 gal. of water per hour that would require replenishing, the rate depending on weather conditions and the temperature of the makeup water.

Testing Condensation in Steam Line—In determining the condensation losses in a steam line with a discharge trap, what allowance should be made for loss of weight of the condensate escaping as vapor to the atmosphere? E. C. E.

The loss of weight would depend on the temperature, and for ordinary temperatures the loss from evaporation would be inconsiderable for the purpose. But very considerable loss is likely to occur when there is violent blowing of the trap discharge valve. This can be prevented, and practically all loss of weight from evaporation eliminated, by having the trap discharge into a barrel of cold water and noting the increase of weight.

Effect of Excess Air on Boiler and Furnace Economy—How does admission of excess air to a boiler furnace affect the boiler and furnace economy? J. D. W.

Any air carried through the furnace in excess of that required for complete combustion chills the fire and lowers the temperature of the products of combustion.

The boiler-heating surfaces are less effective in absorption of the heat of the products of combustion, and there is a total loss of the heat required to raise the temperature of the excess air from the temperature at which it is admitted to the furnace to the temperature at which it is discharged as part of the chimney gases.

Advantages of Shaking Grates—What are the advantages of shaking grates over stationary grates for boiler furnaces? H. A. G.

A leading advantage of shaking or rocking grates over stationary grates is that the fires may be cleaned and ashes removed without the necessity of opening the fire-doors. By their use the grate bars may be given only sufficient motion to remove the ashes without much disturbance of the fire, or should clinkers collect or the coal cake, a more thorough stirring of the fire can be obtained by giving more motion to the grate bars. Another advantage is saving the firemen the labor of slicing the fire while exposed to the heat from open fire-doors.

Reducing Size of Pump Suction—Under what conditions may the suction pipe of a pump be made smaller than the inlet provided by the maker of the pump? J. J. D.

It is to be assumed that the maker has provided for a size of suction pipe that is regarded as the minimum size practicable for the maximum suction when the pump is driven at normal speed. For the same speed of pumping, any reduction in size of the suction pipe causes a loss of suction pressure, due to greater loss of pressure at the entrance and greater suction-pipe friction, requiring more power for operation of the pump and productive of a larger percentage of slippage. But in cases where these are not to be taken into account, the size of suction pipe may be reduced to the size adequate for filling the suction end of the water cylinder when the pump is operated at normal speed.

Smokeless Burning of Sawdust as Boiler Fuel—What type of furnace for a return-tubular boiler is best adapted to burning sawdust without smoke? W. V. M.

The leading requisite for smokeless combustion is that the flame and the distilled gases should not be allowed to come in contact with the boiler surfaces until combustion is complete.

For meeting this condition, probably the best existing form of furnace for burning sawdust as fuel for a return-tubular boiler is the dutch-oven furnace with top feed. This consists of the ordinary setting built out in front of the boiler and containing the grates. The extension is arched over and lined with good firebrick, with a feed hole on top and provided with draft and ordinary fire-doors in the front. The longer path which the hot gases take before reaching the comparatively cool surfaces of the boiler affords an opportunity for them to become mixed with air admitted at the front end of the furnace, and little or no smoke results from the much more perfect combustion than is obtainable with the ordinary form of furnace used with horizontal return-tubular boilers.

Formation of Condensate with Loss of Heat—Does condensation occur if steam at 150 lb. absolute and superheated 100 deg. F., giving it a temperature of 458 deg. F., is deprived of heat so as to reduce the temperature to 358 deg. F., which is the temperature of dry saturated steam at the same pressure?

Is condensate formed when heat is abstracted from dry saturated steam at 456 lb. absolute and the corresponding temperature of 458 deg. F.? L. H. C.

When heat is abstracted from superheated steam and the same pressure is maintained, the heat units so withdrawn are derived from the superheat. The process is the reverse of superheating and no condensate forms. When there is a condition of dry saturated steam (that is, the steam contains no particles of water and the temperature corresponds to the boiling point of water for the given pressure) and the pressure is maintained during the absorption of heat, the heat units so withdrawn are derived from the latent heat and that portion thus deprived of heat is converted into water of the same temperature.

Considering the case where the steam is maintained at 150 lb. pressure and superheated 100 deg. F., abstraction of heat may take place and the temperature may become reduced to 358 deg. F. without formation of condensate; but in the case of dry saturated steam at 456 lb. pressure and temperature of 458 deg. F., if the pressure is maintained, abstraction of heat will be accompanied by formation of condensate.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Navy Test of Lubricating Oil

J. L. Kauffman, in the "Journal of the American Society of Naval Engineers" for August, states that up to about five years ago the Navy Department issued specifications for lubricating oil calling for a certain flash point, specific gravity and viscosity, and usually enumerated several simple tests that would be made. After the establishment of the Engineering Experiment Station, however, study and examination developed a number of special tests, which finally led to a change in the method of purchasing lubricating oils. Instead of requiring oils to meet definite specifications, each was required to pass satisfactorily tests made at the station before being placed on the acceptable list. A memorandum was issued to all firms bidding on navy contracts, setting forth in a general way the tests that would be made.

The old method had the disadvantage that an oil could be submitted which would meet each item of the specifications and still would not lubricate properly [a point well worth noting.—Editor]. Also the requirements of the old specifications regarding specific gravity and flash point were found to limit the bids without increasing the lubricating value.

The important paragraphs of a recent memorandum are:

A. All oils not known to be satisfactory are subject to test at the Engineering Experiment Station, and to a further test in service on board ship when considered necessary, before being considered acceptable.

B. The complete test of an oil consists of three parts, namely: Chemical, physical and practical tests.

C. To successfully pass the chemical tests all oils should be neutral in reaction and should not show the presence of moisture, matter insoluble in petroleum ether (hard asphalt), matter insoluble in ether alcohol (soft asphalt), free sulphur, charring or wax-like constituents, naphthenic acids, sulphonated oils, soap, resin or tarry constituents, the presence of which indicates adulteration or lack of proper refining. Except in oil for engines without forced lubrication, no traces of fixed oils (animal or vegetable fats) should be found.

D. In lubricating oil for main engines without forced lubrication, approved fixed oils, such as rapeseed, olive, tallow, lard and neatsfoot oil may be used. When the foregoing fixed oils are used, they must be well refined with alkalies, unadulterated, containing a minimum of free fatty acids, with no moisture or gumming constituents. Olive oil should not have a high specific gravity. If satisfactory emulsifying results can be obtained with straight mineral oils on engines without forced lubrication, they may be submitted for service test.

E. The physical tests applied to each oil are as follows:

1. { Specific gravity—pyknometer.
   { Baumé gravity.

2. Flash and Fire Point (Cleveland open cup, Pensky Martin closed cup)—The flash point should not be below 300 F., closed cup; and for steam-cylinder oil not below 450 F.

3. Cold Point—The cold point should not be above 32 F., except for cylinder oils. For ice-machine oils it should be as low as possible, at least low enough for the operating condition of minus 15 F. in a dense-air ice machine.

4. Viscosity—The Saybolt Universal Standard Viscosimeter is used. The viscosity of the oils must be sufficient for the purpose intended, and, except for ice-machine oils, must not be less than 140 seconds at 100 F. Viscosity is taken at 100, 130 and 210 F.

5. Emulsion Tests—Emulsion tests are made on all straight mineral oils except cylinder oils. Four emulsion runs are made, using 40 c.c. of oil in each case and (a) 40 c.c. of distilled water; (b) 40 c.c. of salt water; (c) 40 c.c. of normal caustic-soda solution; (d) 40 c.c. of boiling distilled water. The mixture is stirred with a paddle for five minutes at 1,500 revolutions per minute, the mixture being kept at a temperature of 130 F. during the stirring and while settling out. On oils used with forced lubrication or on ice machines, the oil must completely settle out in less than 20 minutes.

6. Friction tests are made on the Experiment Station friction machine to determine the relative friction of various oils under varying conditions of speed, bearing-cap pressure and temperature.

F. Practical tests of oils for forced lubrication are made on the Engineering Experiment Station's 75-kw. turbo-generator, making 2,400 r.p.m., with the temperature of the bearing varying from 180 to 210 F. Tests of ice-machine oils are made on the ½-ton Allen Dense-Air Ice machine. These tests cover a working period of at least 100 hours.

G. Upon completion of the tests at the Engineering Experiment Station, a service test is usually recommended on all but cylinder oils. These tests are made on ships in commission and cover a period of several months.

H. 1. Samples of three oils (light, medium and heavy) should be submitted to be suitable for turbines, all forms of forced-feed or splash lubrication, dynamo engines, and all internal-combustion engines (including Diesel type). These three oils should cover the required range of viscosity.

2. Oil suitable for main engines without forced lubrication should form an emulsion when mixed with water, may be either compounded or a straight mineral oil and must feed efficiently with wick feed, and not be washed off when mixed with water.

3. An oil for use on ice machines in both the compressor and expander cylinders should not give off an objectionable odor when used with the dense-air ice machine.

4. Oil for steam cylinder lubrication must be a straight mineral oil.

5. Oil for cylinders using superheated steam used on shore stations should have a high flash point.

The tests enumerated are then described in a general way.

Moisture—Heat 3 to 4 c.c. in a test tube (the walls of which have been thoroughly wet with oil) in a bath of liquid paraffin up to 300 F. Oils containing water will form emulsions on the walls and cause foaming and spluttering. A test is also made with a mixture of oil and eosin to determine faint traces of moisture by changes of color. The presence of moisture is particularly undesirable in transformer oils, but there is danger of its forming objectionable emulsions in any straight mineral oil.

Sulphur—Boil about 50 c.c. of oil with a piece of bright metallic sodium for half an hour; add water, heat and stir until the sodium is dissolved; pour off the water and test the remainder with a fresh 1 per cent. solution of sodium nitro prusside. If the mixture turns violet color, the oil contains sulphur. When sulphur is found, an additional test for sulphonated oils is made.

Acids or Alkalies—Heat for one-half hour with frequent stirring 25 c.c. of oil and 50 c.c. of neutral distilled water. Test a few cubic centimeters of the mixture first with methyl-orange to determine the acids, and another portion with phenol-phthalein for the determination of alkalies. Acids and alkalies cause emulsions. Acids also cause corrosion of journals and other metal parts.

Matter Insoluble in Ether Alcohol—Shake 11 c.c. of oil and 14 c.c. of ether alcohol (8 parts ether and 6 parts alcohol). After standing 12 hours, note the precipitate, if any, at the bottom of cylinder. The precipitate will be asphalt, and even a trace would make the oil undesirable as a lubricant. Asphalt would cause scoring of journals and clogging of oil lines.

Matter Insoluble in High-Grade Gasoline—Shake 2 c.c. of oil and about 300 c.c. of high-grade gasoline (86-88 Baumé gravity). After standing 12 hours, note precipitate, if any, in the bottom of glass. The precipitate will be soft asphalt or carbon particles, and a slight trace would make the oil undesirable.

Tarry or Suspended Matter—Same as the foregoing, except using 5 c.c. of oil and 95 c.c. of gasoline and allowing it to stand for half an hour; then examine deposit, if any, for dirt or tarry matter.

To Detect Fixed Oils—Heat 10 c.c. of oil with a small piece of metallic sodium. If the mixture becomes gelatinized or a semisolid, it indicates the presence of fixed oils. If an equal volume of oil is heated alone to the same temperature, the viscosity of the two samples can be compared; if the oil contains fixed oils (animal or vegetable oils), the sample with sodium will be much heavier than the sample heated alone.

Effect of Heat—Heat 5 c.c. of oil in test tube over flame until vapors are evolved and compare the color of the heated oil with that of unheated oils. If the heated oil turns black, it shows the presence of undesirable carbon or hydrocarbons.

The physical characteristics are determined as follows:

Color—The color, although having no influence on the lubricating value, may be used to identify the sample. American oils fluoresce with a grass-green color. Russian oils have a blue sheen; oils containing distillation residues and unfiltered oils are brown to green-black in reflected light. Nearly all mineral machinery oils are distilled and filtered to some extent and are transparent in a test tube, the colors ranging from a yellowish white to a blood red. The color may be determined in a tinctometer by comparing with different-colored glasses or lenses. These glasses are numbered and for machinery oil extend from No. 1 (white) to No. 6 (red).

Odor—The odor may be determined by heating in a test tube or by rubbing on the hand, by which means fatty oils, coal tar, rosin oils, etc., may be detected.

Specific Gravity—The specific gravity is obtained by the use of the "pyknometer," this term signifying any vessel in which an accurately measured volume of liquid can be weighed. The bottle is first filled with distilled water at a temperature of 60 F. and the weight of the water determined. The bottle is then filled with oil at a temperature of 60 F. and the weight of the oil determined. The weight of the oil divided by the weight of the water gives the specific gravity at 60 F. The Baumé gravity is obtained by using the Baumé hydrometer, which is simply an ordinary hydrometer with a certain arbitrary scale. Baumé gravity may be converted into specific gravity by the following formula:

$$\text{Sp. gr.} = \frac{140}{130 + \text{Baumé}}$$

Baumé gravity is largely used in commercial practice.

The specific gravity does not affect the lubricating value of an oil, but indicates to the experienced oil man the locality from which the crude oil is obtained. For instance, the specific gravities of the lubricating oils tested at the Experiment Station vary from 0.864 to 0.945. A Baumé gravity of 32 corresponds to a specific gravity of 0.864, and a Baumé gravity of 18.1 to a specific gravity of 0.945, so that an increase in specific gravity is a decrease in Baumé gravity. The paraffin-base oils of Pennsylvania derivation have an average specific gravity of 0.875 with a corresponding Baumé gravity of 30. The asphaltic-base oils from Texas and California have an average specific gravity of 0.930 with a corresponding Baumé gravity of 20.

METHODS OF DETERMINING FLASH POINT

Flash Point—The flash point is determined with both the Cleveland open cup and the Pensky-Martin closed cup. The flash point of all oils is determined as a measure of their volatility. The flash point of steam-cylinder oils is of primary importance, the required flash point depending on the temperature of the steam at the engine. With lubricating oils for bearings the flash point is important only in that it indicates the volatility of the oils and the presence of kerosene or naphtha fractions, with the accompanying fire risks. In the case of very low flash-point lubricating oils, it is desirable to run a special distillation or volatility test, mentioned under chemical tests. The flash point determined with the open cup is higher than with the closed cup, as the inflammable gases on the surface of the oil are disturbed by the air currents in the open cup. These differences range from 5 deg. to 40 deg., with the average at 20 deg. The presence of very light ends (kerosene, naphtha, etc.) may increase this difference to 100 deg.

Fire Point—This is the temperature at which the oil burns and is determined by raising the temperature about 3 deg. a minute, applying the flame for about a second. The fire, or burning, point is from 30 deg. to 65 deg. higher than the flash point with all lubricating oils, the light oils having a difference of about 40 deg.

Cold Point—Mineral oils become more viscous on cooling, and finally solidify. In lubricating oils refined from paraffin-base crudes, cooling first causes the paraffin particles to solidify, which gives the oil a cloudy appearance; with this class of oils this change is known as the cloud point.

THE COLD TEST DEFINED

The Committee on Lubricants of the American Society for Testing Materials uses the words "cold test" as a general term, with subheads of "cloud test" and "pour test." The method recommended by this committee is used at the Experiment Station, and in substance is as follows: Heat the oil to 150 F. and cool by air to 75 F. Take a bottle about 1¼ in. inside diameter and 4 to 5 in. high and pour in oil to a height of 1¼ in. from the bottom. Insert a cold-test thermometer (specially made, using colored alcohol, and with a long bulb) through a tight-fitting cork. A special jacket is used having an inside diameter about ½ inch larger than the bottle. Ice or any other cooling medium is packed around this jacket. When the oil is near the expected cloud point, at every 2 deg. drop in temperature remove the bottle and inspect the oil, being careful not to disturb the oil. When the lower half becomes opaque, read the thermometer; this reading is taken as the cloud point. The cold, or pour, test is simply a continuation of the cloud test, except that the temperature is noted every 5 deg. and the bottle tilted till the oil flows. When the oil becomes solid and will not flow, the previous 5-deg. point is taken as the cold point of the oil. In the naval service a low cold point is required only on ice machines. All ice-machine oils should have a cold point of minus 15 F., which will permit a brine temperature of minus 20 F. Oils used on motor-boat engines should have zero cold test if the boats are used in cold climates. The lubricating oils refined from asphalt-base crudes, or Southern crudes, have a natural cold point around zero degrees; these oils do not show cloudiness before solidifying. The oils from paraffin-base crudes, or Northern crudes, must be run through the filter presses to squeeze out the paraffin before a low cold test can be obtained.

Viscosity—The viscosity of a lubricating oil is the most important constant to be determined. The viscosity of an oil is inversely proportional to its fluidity and is a measure of its internal resistance, or resistance to flow. The absolute viscosity is determined from the amounts flowing through capillary tubes, the results being given in C. G. S. units. The determination of the absolute viscosity is a very difficult operation requiring complex apparatus and a relatively long time. Several absolute viscosimeters have been invented; but to date none of them are considered practical enough for the routine testing of oil.

The accepted theory advanced by Ubhelohde[1] is that the viscosity (absolute) is directly proportional to the internal friction of the lubricant, and that the viscosity is a direct indication of the friction developed in a bearing.

Under normal conditions of bearing lubrication, the lightest oil that will prevent seizing should be used to obtain a minimum frictional loss.

Friction tests as shown by the station's friction machine are comparative only, the results being simply the friction obtained by using various oils on this particular bearing. Tests have been made that show that the friction is directly proportional to the viscosity of the oil at the temperature of the bearing.

Emulsion Tests—The method of conducting the test is described in the memorandum quoted at the beginning of this article. The emulsion is made with distilled and salt water, and a normal caustic-soda solution is also taken, as there is a possibility of water containing boiler compound getting into the system. Boiling distilled water is used in case gland steam or water runs into the oil system. These emulsion tests are considered of the greatest importance, as an oil on any type of forced lubrication system must not emulsify. If emulsions do occur, it will mean clogging of the oil lines, forming of residues in the base of the bearings, with a resultant loss of a large amount of oil.

Practical Tests—All oils submitted for forced-lubrication purposes are given a working test on the Experiment Station 75-kw. turbo-generator for 100 hours, with the generator running at 2,400 r.p.m. The oil is placed in the main bearing, which has ring-feed lubrication, and a careful record is made of the temperatures and of the amount of oil required to keep the reservoir full. After the test the bearing and journal are examined and the oil is analyzed and tested. From the examination after use in the turbine, the action of an oil in service can be predicted as far as its lubricating value is concerned. Service tests are made on board ship, and it is a comparatively easy matter to obtain satisfactory oils by the employment of the tests enumerated and from the large amount of data accumulated at the Experiment Station. Whether an oil will prove satisfactory can be closely predicted by a consideration of the results obtained on the preliminary tests.

Special tests—Due to the relatively small amount of information obtainable on the action of lubricants in service, it is necessary to continually develop new tests in order that the new types of machinery may be properly lubricated.

At present the study of oils after several hundred hours' use in service is being made. Particular attention is being paid to the loss of oil by vaporization or volatilization, and the resulting characteristics of the remaining oil in the system.

[1] "The Theory of Lubrication," by L. Ubhelohde, "General Electric Review," November, 1915.

How Cork Insulation Is Made

Cork for cold-storage insulation is chiefly a byproduct of the cork-stopper industry. The raw product is the bark of the cork oak, native in the Mediterranean countries. At the age of 30 years the bark is of sufficient thickness to be stripped and, unlike most trees, removing the bark aids the growth and prolongs the life of the tree. The bark is first boiled to remove the dirt and impurities, during which process its volume is increased about 25 per cent. It is then shipped to the manufacturers of cork products, where the best material is used for making cork stoppers and the like; but the enormous waste, amounting to 60 to 70 per cent., together with the coarser pieces of bark, goes to make up sheets of insulation, principally used for cold-storage work.

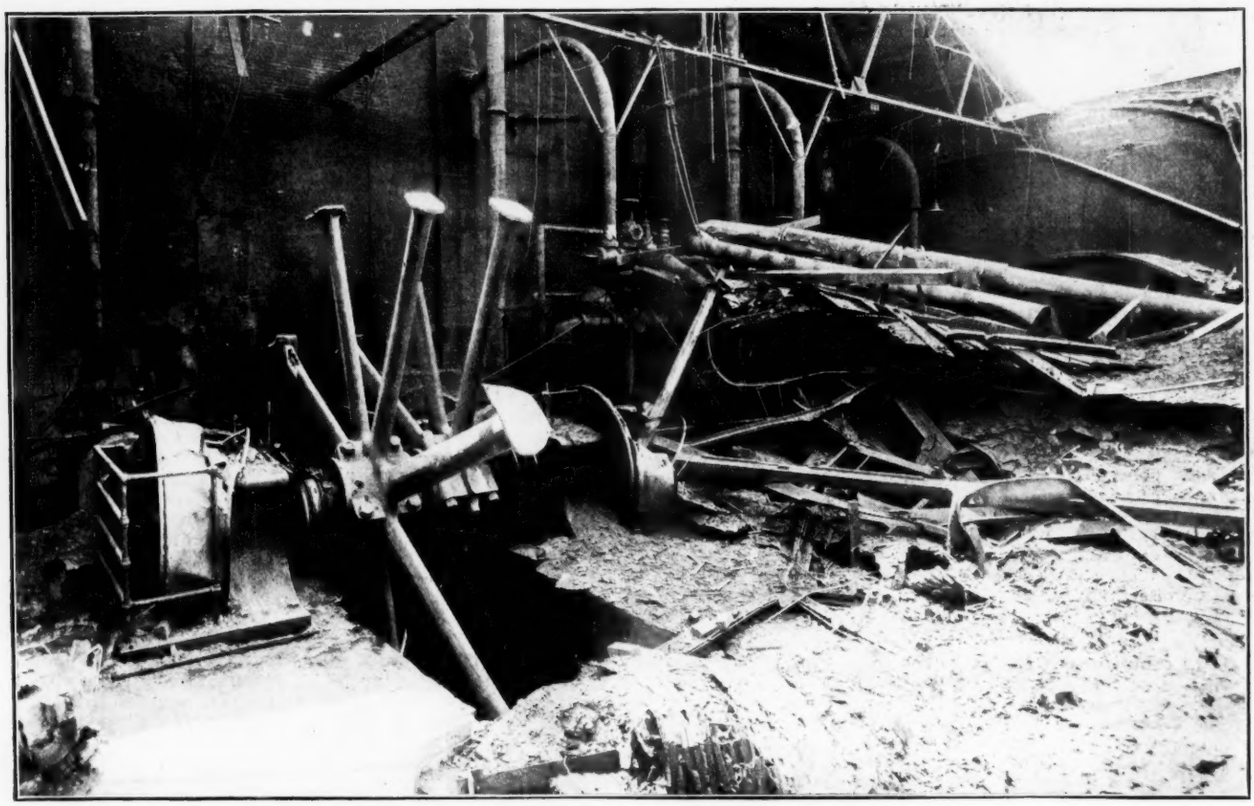
After the cork has been sized and cleansed (free from dust), it is placed in steel molds and there compressed. While under pressure the cork is thoroughly baked and then gradually allowed to cool. This baking process drives out the moisture and causes the natural sap to form a glue, which binds all the particles into a homogeneous mass. By driving out the moisture and destroying the impurities by the heat treatment, more air cells result and consequently a more efficient insulator is produced. Turning the sap into a glue greatly increases the waterproofing qualities, which is one of the large factors to be thought of in choosing an insulating material.

After being removed from the mold, the edges of the cork sheets have to be trimmed and trued up into sheets 3 ft. long, 1 ft. wide, standard thicknesses of 2 in., 3 in. or 4 in. Other forms of cork board are made where the particles are united by means of asphalt and formed into sheets of the same size as those described.—C. B. Rowley, before the Cleveland Engineering Society.

Flywheel Wreck at St. Louis

The illustration shows the wreckage caused by the bursting of the flywheel or main driving belt-wheel on a 22&44x48-in. cross-compound Hamilton Corliss engine, 83 r.p.m. normal speed, at the works of the Portland Cement Co. at St. Louis, Mo., Aug. 23, instantly killing the engineer and injuring five others, a brief note of which was made in "Power" in the issue of Sept. 5.

The belt-wheel was 20 ft. in diameter and 68 in. face, built up of two wheels side by side and each of half-section construction, bolted at the hubs and rims, no shrunk links being used. The rims of the two wheels were bolted together



WRECKAGE CAUSED BY THE EXPLOSION OF A 20-FT. FLYWHEEL

circumferentially through a flange extending inward on the inner sides of the rims, forming a built-up double-spoke wheel. The mean thickness of the rim was about 5 in.

An eyewitness who was in the engine room states that his attention was attracted to the engine by what seemed to be unusual speed and a fine dust being shaken from the flywheel. He sounded the engine-room alarm gong calling the engineer from an adjoining room where the latter was engaged in soldering an oil can.

The engineer responded promptly and made a brave attempt to reach the throttle, the stem of which extended inward or between the cylinders; but when he was about midway between the two cylinders, the flywheel let go and he was instantly killed.

An oiler in the plant testified that the governor drive, a cemented-joint endless belt, was in first-class condition and that the engine could not be started by opening the throttle when the governor had dropped to its lowest position, indicating that the safety cams were in working order. He stated, however, that recently the governor had caused trouble at the miter gears, probably from wear during long-continued service.

There seems to be no doubt that the flywheel exploded from overspeed caused by the failure of the governor. The lack of an automatic or remote-control engine stop and the absence of the engineer from the engine room, making it impossible for him to observe the change in speed, are outstanding features.

The fact that the throttle wheel was located between the cylinders opposite, or in front of, the flywheel may have been directly responsible for the death of the engineer. The monetary loss is estimated at about $160,000.

Flow of Water in Pipes

The following table is a combination of two tables usually detached, but it is believed that it will be found more convenient in the present form. Under the headings "Velocity" will be found, opposite the various quantities and under the pipe sizes, the velocity in feet per minute with which water must flow to discharge the number of gallons in the first column from a given (clean iron) pipe. Under "Pressure Drop" will be found the corresponding loss in pressure per square inch through a pipe 100 ft. long or the equivalent in bends, fittings or other sources of friction and pressure drop. For lengths greater or less than 100 ft. the friction loss or drop in pressure increases or decreases in direct proportion, while the velocity must of course remain the same:

FRICTION AND FLOW OF WATER IN PIPES

Best Manufacturing Co.

Gal. per Min.	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop
	¾-In. Pipe		1-In. Pipe		1¼-In. Pipe		1½-In. Pipe	
5	218	3.3	122½	0.84	78½	0.31	54½	0.12
10	436	13.0	245	3.16	157	1.05	109	0.47
15	653	28.7	367½	6.98	235½	2.38	163½	0.97
20	872	50.4	490	12.3	314	4.07	218	1.66
25	1,090	78.0	612½	19.0	392½	6.40	272½	2.62
30			735	27.5	451	9.15	327	3.75
35			857½	37.0	549½	12.4	381½	5.05
40			980	48.0	628	16.1	436	6.52
45					706½	20.2	490½	8.15
50					785	24.9	545	10.0
75					1,177½	56.1	817½	22.4
100							1,090	39.0

Gal. per Min.	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop	Velocity	Pressure Drop
	2-In. Pipe		2½-In. Pipe		3-In. Pipe		4-In. Pipe	
5	30½		19½		13½		7⅝	
10	61	0.12	38		27		15¼	
15	91½		58½		40½		23	
20	122	0.42	78		54		30⅝	
25	152½		97½	0.21	67½	0.10	38⅛	
30	183	0.91	117		81		46	
40	244	1.60	156		108		61¼	
45	274½		175½		121½		69	
50	305	2.44	195	0.81	135	0.35	76⅝	0.09
75	457½	5.32	292½	1.80	202½	0.74	115	
100	610	9.46	380	3.20	270	1.31	153⅛	0.33
125	762½	14.9	487½	4.89	337½	1.99	191⅝	
150	915	21.2	585	7.00	405	2.85	230	0.69
175	1,067½	28.1	682½	9.46	472½	3.85	268⅛	
200	1,220	37.5	780	12.47	540	5.02	306⅝	1.22

Refrigeration Plant Explosion

On the afternoon of Sept. 14, the receiver tank of a twenty-ton refrigerating plant belonging to the Interstate Milk and Cream Co., of Newark, N. J., exploded, instantly killing six men, including the president and secretary of the company, a seventh later succumbing to injuries, and seriously injuring four others. The plant was a new one on which the final tests were being made preparatory to turning it over to the owners. Without much of a report and doing comparatively little damage to the building, the receiver opened its entire length, as shown in the illustration.

DISASTROUS EFFECTS OF THE AMMONIA-RECEIVER EXPLOSION

The receiver had been tested to 300 lb. air pressure, and about three weeks prior to the accident a preliminary test had been run on the plant, at which time everything was found to be working satisfactorily. The normal working pressure of this system is 125 lb.

The plant was in charge of the supervising engineer, who was killed by the explosion. Details as to what happened just previous to the accident are very meager, but from what can be obtained from those who survived, it is understood that the condensing water failed, owing to a fuse blowing on the circulating-pump motor. The dairy company's engineer went into the basement to replace the fuse, but before he had time to return the explosion occurred. It is supposed that the accident was caused by leaving the compressor running when the circulating water failed on the condenser. The gas not being condensed, the compressor increased the pressure to the point where something had to give way, there being no relief valves; and as the receiver was the weakest point, it ruptured. When the rupture occurred the reduced pressure caused whatever liquid ammonia there may have been in the system to be immediately converted into gas with a consequent effect similar to a boiler explosion.

There was 1,000 lb. of ammonia in the system at the time of the accident. As can be seen in the illustration, the indications are that the pressure was very high when the receiver gave way, as the shell of the tank is practically straightened out for about 50 per cent. of the circumference.

The receiver was 20 in. diameter and 10 ft. long, with a $\frac{7}{16}$-in. shell, the seams autogenous-welded. From all appearances, the longitudinal seam failed about midway between the headers, and starting at this point, it opened the entire length. One header seam opened for about $\frac{3}{4}$ of the circumference, the other $\frac{3}{4}$ of the circumference, as shown by the illustration.

From an examination of the break it is obvious that whatever else may have been contributory to the explosion, part of the welding was defective. For about one-half the length of the longitudinal seam the weld has the appearance of being well made, but in the other half the metal does not seem to have been melted for more than about one-half the thickness of the shell. The indications are that the shell first gave way at about the beginning of the defective welding.

There is probably no doubt that the plant was constructed according to general practice in vogue at the present time. However, the explosion shows that a refrigeration system is just as dangerous or more so than a steam boiler when not properly handled, and therefore should be equipped with the proper safety devices.

It is believed that further investigation will show that safety valves are a necessary part of a refrigerating plant and that this accident could have been prevented if they had been installed. As the terse saying goes, a reliable engineer is the best safety valve. This is probably true, but it is impossible for the reliable engineer to be always on the job, consequently it would seem to be good policy to install proper safety devices to make the refrigeration system safe in his absence.

Important Valuation Decision

The California Railroad Commission has fixed a valuation of $6,328,000 on the electric distributing system of the Southern California Edison Co. in Los Angeles in connection with its intended purchase by the City of Los Angeles. The company contended that the property plus severance damages was worth $21,890,000, while the municipality set upon it a value of $3,473,803.

The decision sets a precedent in regard to the fixation of severance damages; that is, the damages suffered to the remainder of the system by an excision of the Los Angeles portion. The opinion fixed the actual value of the system at $4,750,000, allowing in addition severance damages of $1,578,000.

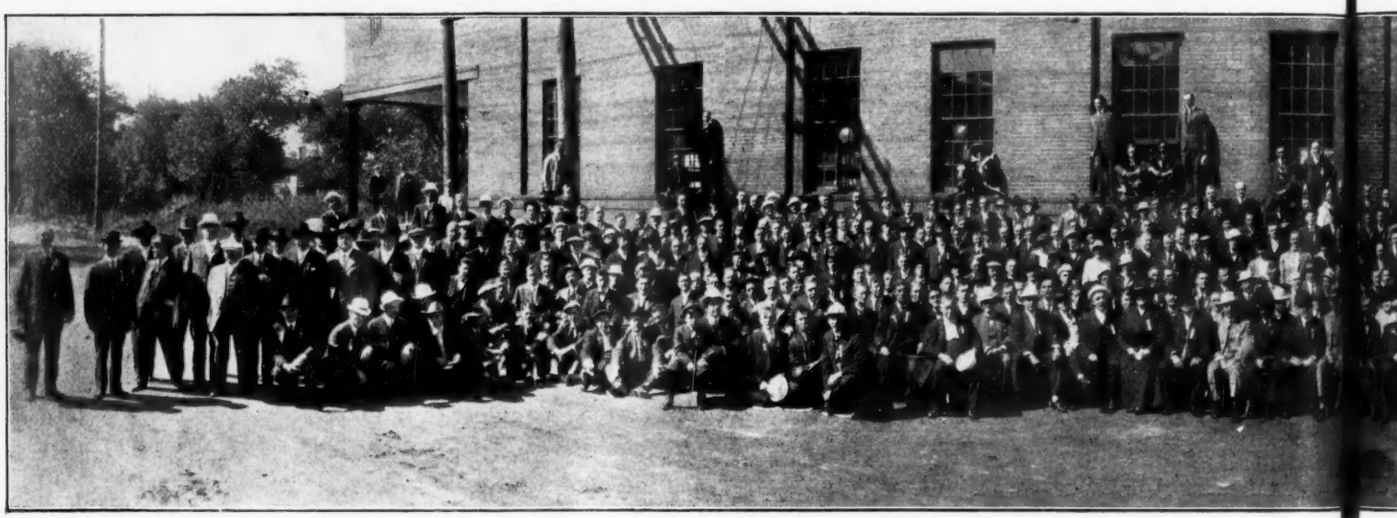
The decision stated that reproduction costs rather than the capitalization of earnings was the basis taken, and that the Commission worked with a clear understanding of the necessity of an award which, by its fairness, would encourage further investments of capital in the state.

Power in the Knitting Industry—The first instance in which power was successfully applied to the stocking-knitting frame occurred in 1832 at Cohoes, N. Y., whereas in England power frames were not generally introduced until after 1845, according to a statement in a bulletin lately issued by the Massachusetts Minimum Wage Commission on wages of women in knit-goods factories in Massachusetts.

N. A. S. E. Annual Convention at Minneapolis

From Sept. 11 to 16 the National Association of Stationary Engineers held its thirty-fourth annual convention at Minneapolis, Minn. Headquarters was at the West Hotel, and the Pence automobile warehouse was secured for the exhibits and the sessions of the convention. Although the delegates registered were fewer in number by one-fourth than the average of recent years, the convention was a decided success. The executive sessions were started promptly and conducted on a business basis. The various talks at the opening and succeeding sessions were uniformly good and of a character that appealed to the engineers. Enthusiasm and a lively interest in the affairs of the organization were in evidence throughout the week.

Monday, as usual, was devoted to registration and to escorting delegates from the depot to headquarters. Charles A. Wilhoft, the local committee and a band were on the job from start to finish. In the evening the mechanical exposition was officially opened, J. M. Williams, local chairman, presiding. Lane Thompson, president of the National Exhibitors' Association, addressed the gathering and National President Damon responded. A reception to the national officers in the Moorish Room of the West Hotel was followed by informal dancing until midnight.



ENGINEERS, EXHIBITORS AND LADIES ATTENDING THE THIRTY-FOURTH ANNUAL CONVENTION OF THE

Inclement weather Tuesday morning prevented the usual parade from headquarters to the convention hall. The session opened promptly with Chairman Williams holding the gavel. The conventioners were thrice welcomed by Hon. J. A. A. Burnquist, governor, in behalf of the state; by W. G. Nye, mayor, and by L. F. Blyler, in behalf of the Minneapolis Civic and Commerce Association. The governor, being a member of the N. A. S. E., knew that the association stood for education and the safety of the public. He was familiar with the efforts to secure reasonable state license laws, and offered to do anything within his power to help the cause in Minnesota. In respective order responses were made by President Damon, Vice-President Kerley and John Lane. Rev. James E. Freeman, who at one time had been a locomotive engineer, gave the closing address. With a number of apt illustrations the speaker pointed out the benefits to be derived from coöperation and efficiency. The isolated man who contributes nothing toward the general welfare of mankind is a danger to our national life and should be shunned.

After the presentation of a gavel to President Damon by No. 8 of Minnesota, the business sessions were officially opened and the usual committees appointed.

In his annual report at the afternoon session, President Damon recommended that some arrangements be made so that the members might receive the benefit of the courses in the International Correspondence Schools already provided for; that $1,000 be given the Educational Committee for distribution among the state educational committees; that the Educational Committee be composed of three members, one to be elected each year, instead of five members as at present; that 5 per cent. of the gross income, up to $10,000, be laid aside in a separate fund for emergencies and any withdrawal be made only upon a two-thirds vote of the Board of Directors; that $3,500 be appropriated to the president to engage a permanent organizer for the purpose of building up the organization in numbers and quality; that the association select a central convention city for 1917. These recommendations were put before the convention and, with the exception of the plea for a special deputy, received favorable action. The Educational Committee was voted $2,000.

The secretary gave the membership as 22,366. The receipts for the year were $32,211.82, which, with a balance on hand of $16,394.40, made a total of $48,606.22. The expenditures were $23,594.72. The Credential Committee reported 314 delegates.

John A. Kerley, national deputy and vice-president, in a tabulated report showed that nine new associations were instituted, four were reinstated, six charters returned, three disbanded and ten dropped for nonpayment of the tax, making a net loss of six.

The Educational Committee reported that during the year some 400 lectures had been given. One new lecture on "Corliss Valve Gears" had been placed before the members, and contracts were let for five new lectures with slides, covering refrigeration, turbines, boilers, stokers and pumps and pumping machinery. The expenses of the committee were $670.54, which increases to $1,450.54 when the contracts for the new lectures are included. The committee recommended that $2,000 be appropriated for educational purposes during the coming season and that steps be taken to provide lectures on elevators, indicator diagrams, slide valves, and heating and ventilation; the immediate appointment of a committee to secure power-plant data; the continuation of the prize contests; that reprints be made of the questions and answers.

As there were few states in which the legislature met and with no money for the work, the License Committee's report showed little progress. Rhode Island had a bill before the legislature, but it was defeated. Washington, Wisconsin, Maryland and Colorado reported activities on engineers' license laws.

A lecture by Dr. C. A. Prosser, director of the Dunwoody Industrial Institute, on the aims and accomplishments of this most practical and richly endowed trade school completed the afternoon session of Tuesday.

On Wednesday morning Thomas W. Roberts, of Cleveland, spoke on the necessity of a systematic method of arranging data regarding license laws, to include not only laws and ordinances in effect, but also all the court decisions bearing on such enactments. These data should include records of all bills that had failed to pass and the reasons therefor. The speaker repeatedly warned license committees not to attempt too much in the first bill. His advice was to try for a reasonable bill and amend it later as need be.

J. D. Taylor, of New York, talked on the "Isolated Plant vs. the Central Station," explaining the situation as it existed in his home city. One of the greatest needs was the keeping of

accurate records by the engineer, so that he may be able to defend his plant against the solicitation of the central station. Other speakers followed along the same lines.

Prof. J. J. Flather, of the University of Minnesota, lectured on "The History and Development of Engineering and Its Relation to the Arts and Sciences." The session adjourned, and all assembled for the official picture taken at the side of the Pence automobile warehouse.

At the afternoon session the mileage committee reported a total mileage of 287,169, calling for an expenditure at 5c. a mile of $14,380.95. Welfare talks and a lecture on "Flour Milling in Minneapolis," by H. F. Mueller, chief engineer of the Washburn Crosby Co., preceded a visit to the plant under discussion.

The Life and Accident Department reported that approximately $31,500 had passed through the office, entailing 88,500 entries. The benefit fund with last year's balance totaled $27,643.79, the disbursements $27,002, leaving a balance in the treasury of $641.79. Claims to the number of 54 were paid. The expense fund showed a balance of $925.47 on Sept. 1, 1916, and the reserve fund amounted to $956.54. During the year 181 new members were obtained and 110 canceled, making the total membership 3,555. Judson Pratt, of Cincinnati, was elected chairman of the Board of Trustees and J. D. Taylor, secretary-treasurer for the eighth consecutive time.

At the field-day contests Thursday afternoon the engineers won the ball game by the score of 8 to 0. Other entertainment was a stag theater party at the "Gayety," in which the "Bunch" were an enjoyable addition to the regular show. Next evening they repeated at the convention hall. Theater parties and sight-seeing trips were arranged for the ladies.

On Friday the following officers were elected: John A. Kerley, Cincinnati, president; John A. Wickert, Milwaukee, vice-president; Fred Raven, Chicago, secretary; Samuel B. Forse, Pittsburgh, treasurer; Joseph O'Connell, Chicago, trustee of "National Engineer"; George I. Vaughan, Salt Lake City, conductor; C. Manker, Mobile, doorkeeper.

The newly elected officers were installed by Dad Beckerleg at the opening of the ball Friday evening. Evansville, Ind., was chosen as the next convention city.

At the close of the convention the engineers and exhibitors combined in the following presentations: A Knight Templar's charm to J. M. Williams, local chairman; a diamond ring to Walter H. Damon; a purse of money to Lane Thompson, retiring president of the National Exhibitor's Association. In respective order the presentations were made by J. W. Peterson, William Reynolds and Harry Pastre. The past president's jewel was conferred upon Retiring President Damon by Fred Raven.

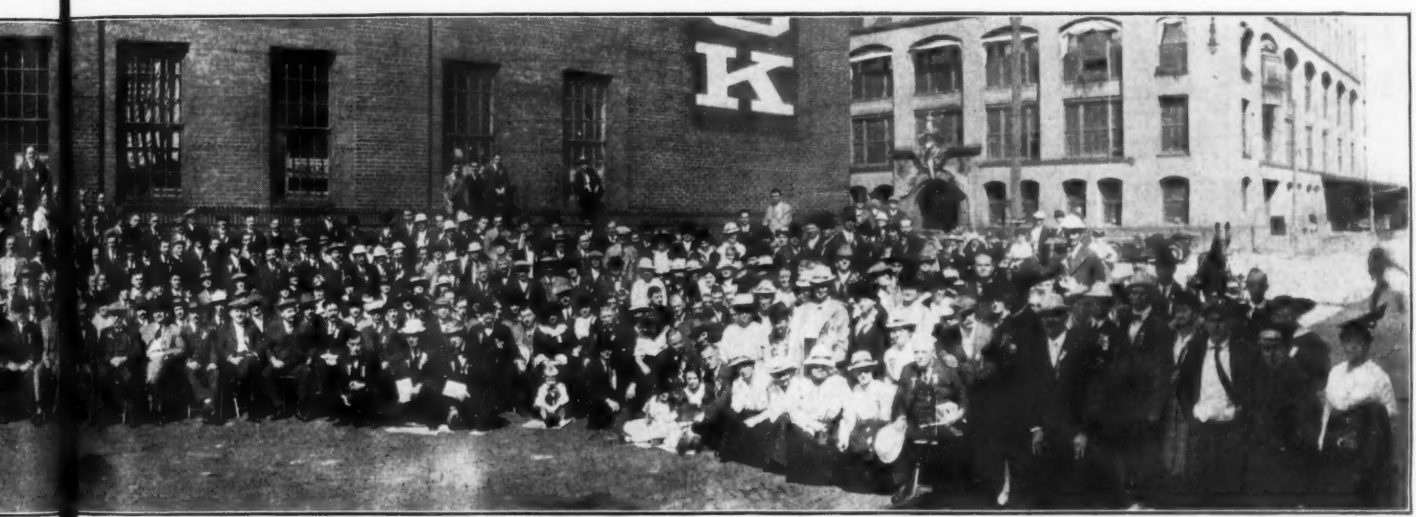
The Ladies' Auxiliary announced that pensions had been increased from $15 to $17 per month. At the annual collection they received $108.05. Their election resulted as follows: Margaret A. Flinn, Chicago, president; Sadie Armer, Milwaukee, vice-president; Lenore W. Farmer, Columbus, secretary; Emma M. Stone, Framingham, treasurer; Mary T. Mahon, Chicago, conductor; Mrs. Charles Roth, Cincinnati, doorkeeper. Mrs. Alvina Caffin, Indianapolis, chaplain.

The exhibits were good and attractive as usual, although the booths were not so numerous as at recent conventions. The National Exhibitors' Association elected the following officers: H. D. Raymond, A. W. Chesterton Co., president; Paul T. Payne, Dearborn Chemical Co., vice-president; Horace A. Smith, Philadelphia Grease Co., treasurer; J. W. Peterson, Richardson-Phenix Co., secretary; L. W. Brooks, Joseph Dixon Crucible Co., executive committee.

Serious Tube Failure at Fisk Street Station

One of the second bottom tubes in a 500-hp. water-tube boiler at the Fisk Street Station of the Commonwealth Edison Co. burst about 9 a.m., Saturday morning, Sept. 16, while carrying full load. Four men were scalded seriously, one who was working the fire at the time succumbing to his injuries a few hours later. The boiler was one of a battery serving a 12,000-kw. turbo-generator. The unit had been placed back in service only about six hours before the accident, after having been shut down for its annual overhauling. This is the first fatal accident, chargeable to the boilers, since Fisk Street station has been in operation. The result would undoubtedly have been far worse, had not automatic nonreturn valves been installed. As it was no service interruptions occurred.

The boiler room at Fisk Street contains eighty 500-hp. boilers supplying ten 12,000-kw. turbo-generators, and eight 1,225-hp. boilers supplying one 25,000- and one 30,000-kw. generating units.



NATIONAL ASSOCIATION OF STATIONARY ENGINEERS, PENCE AUTOMOBILE WAREHOUSE, MINNEAPOLIS, MINN.

ENGINEERING AFFAIRS

The Smoke Prevention Association will hold its eleventh annual convention in St. Louis, Mo., Sept. 26-29, with headquarters at the Planters Hotel. A practical demonstration will be given showing how smoke can be prevented in locomotive practice, and the following papers will be presented: "The Smoke of Heating Plants," by O. Monnett, of Chicago, and "Heating Boilers and Furnaces," by W. A. Pittsford, of Chicago, on Tuesday afternoon. On Wednesday: "Up-To-Date Smoke Regulation," by J. W. Henderson, Chief of Bureau of Smoke Prevention, of Pittsburgh. "Chimney Draft and Its Relation to Boiler and Furnace Operation," by Edward R. Fish, vice-president of Heine Safety Boiler Co., of St. Louis. "The Development of Stokers and Its Relation to Smoke Abatement," by Joseph G. Worker, of East Pittsburgh. "Soot Fall Studies," by John J. O'Connor, Jr., of Mellon's Institute of Industrial Research, University of Pittsburgh. On Thursday: "Burning Powdered Coal on Locomotives," by Charles W. Corning, Chief Inspector, C. & N. W. R. R., Chicago. "Railroad Smoke Elimination," by H. H. Maxfield, Supt. of Motive Power, Western Penn. Division, Penn. R.R., Pittsburgh. "Firing Up Engines at Engine Round Houses," by A. E. Langreck, of St. Louis. "Developments in Smoke Abatement Devices of Locomotives," by J. H. Lewis, Chief Smoke Inspector, C. B. & Q. R.R., Chicago. On Friday: "The Carburization and Burning of Powdered Coal as Fuel," by Alonzo G. Kinyon, of Chicago. This will be followed by a business session and a trip to the Anheuser-Busch brewery.

The American Association of Refrigeration will hold its sixth annual meeting at the Congress Hotel, Chicago, Oct. 11, 12 and 13. An exhibition will be held in connection with the meeting.

The American Institute of Steam Boiler Inspectors will hold its regular meeting in the Engineering Societies' Building, 29 West 39th St., New York at 8 o'clock, Friday evening, Sept. 29.

The New York School of Heating and Ventilating will open its fourth annual season on Oct. 9. The classes will meet in Room 511, World Building, Park Row, the first-year class on Monday evenings at 7:30 and the second-year class on Wednesday evenings at the same hour.

OBITUARY

Emil Herter, chief mechanical engineer of the Edison Storage Battery Co., West Orange, N. J., died Aug. 24 in his 59th year.

Henry Horne, for years an erecting engineer with the Allis-Chalmers Co., of Milwaukee, Wis., died recently at the home of his daughter, in Anniston, Ala. He had charge of the installation of many water-works plants throughout the country.

John Muir, supervisor of power plants for the New York Telephone Co., with which company he had been connected for eight years, died at his home in Glen Ridge, N. J. on Sept. 12, in his sixtieth year. He was born in Scotland and after serving his apprenticeship in the engineering works of Scott & Co., Greenock, he entered the employ of Caird & Co., where he worked for a number of years, afterwards working as a marine engineer between Glasgow and the East Indies and later between New York and the West Indies. He is survived by a widow and two daughters.

TRADE CATALOGS

Pipe and Boiler Coverings, etc. Ehret Magnesia Mfg. Co., Valley Forge, Penn. Catalog. Pp. 62; 5½x8 in. This describes the 85% magnesia coverings made by this company, also asbestos and wool felt coverings, and contains specifications for magnesia insulating covering or lagging material.

Webster Vacuum System of Steam Heating—For highly specialized technical information the modern catalog is of more avail than textbooks or works of reference. The 114-page 8x10 monograph on the Webster vacuum system of steam heating, just issued by Warren Webster & Co., of Camden, N. J., describes in a way that will appeal to any engineer the design and installation of that system, with generous illustrations of all its details, tables of pipe capacities, etc., and outline presentations of different piping systems. Webster appliances and accessories are illustrated and described in detail, and the book is replete with halftone illustrations of buildings in which the Webster vacuum system is in use. It may be had free upon application.

PERSONALS

Frank E. Howells, superintendent of shops of the Steelton plant of the Bethlehem Steel Co., has been appointed assistant mechanical engineer of the plant.

Dr. Allen D. Risteen, engineer of the Travelers Insurance Co. and the Travelers Indemnity Co., of Hartford, Conn., has been appointed director of Technical Research and Safety Publication Work of the company.

James G. Bailey, formerly chief engineer of Armour & Co., of Chicago, with which concern he had been connected for 14 years in the mechanical department, is now superintendent of machinery with the Sullivan Packing Co., of Detroit, Mich.

William Ferguson, formerly supervising engineer of the Travelers Insurance Co. and the Travelers Indemnity Co., of Hartford, Conn., at Detroit, Mich., has been promoted to traveling supervising engineer with headquarters at Hartford.

John L. Thompson, formerly supervising engineer of the Travelers Insurance Co and the Travelers Indemnity Co., of Hartford, Conn., has been made superintendent in general charge of the engineering and inspection division of the company.

Proposed Construction

Ark., Cave Springs—Snowden Engineering Co., recently incorporated with $500,000 capital stock, plans steam-driven electric plant. G. H. Snowden, Kansas City, Mo., Pres.

Colo., Boulder—W. S. Campbell, Mechanical Engr., Denver, made plans for water power sites for hydro-electric power plant at mouth of Boulder Cañon to develop about 4,000 hp. About $250,000.

Fla., Lake Butler—City plans electric-light plant. B. M. Wilson, Mayor.

Ill., Montgomery—Montgomery Hydro-Electric Co. retained H. A. Strauss, Harris Trust Bldg., Chicago, as consulting engineer in connection with proposed hydro-electric development on Fox River.

Ind., Michigan City—City voted $10,000 bonds for heating plant at courthouse. E. G. Dunn, City Engr.

Ind., South Bend—St. Joseph County Anti-Tuberculosis Hospital Association plans power plant at hospital. G. O'Brien, Pres., Bd. Dirs.

Ill., Teutopolis—Eastern Illinois Utilities Co. granted franchise by Village Bd. for electric-lighting system.

Iowa, Farmington—City plans to rebuild electric-light plant recently destroyed by fire.

Iowa, Kensett—Citizens voted to grant Kensett Light Co. franchise for electric-light, heating and power system in Kensett.

Kan., Jetmore—City plans $10,000 bond issue for enlarging electric-light plant and water system.

Ky., Perryville—Russell Bros. Co. making plans for electric-light plant. About $50,000.

Mass., Westfield—Town plans election to vote on additional appropriation for electric-light plant.

Mich., Lansing—W. K. Pruden receiving bids about Oct. 1 for power house. B. E. Parks & Son, Houseman Bldg., Grand Rapids, Engr.

Minn., Lancaster—City plans to install electric-light plant.

Minn., Lester Prairie—Northwest Light and Power Co., Hutchinson, plans to install electric distributing system in Lester Prairie.

Minn., Wanda—R. Wherland granted franchise to construct electric-lighting system.

Mont., Cut Bank—Council plans election to vote on franchise for electric-lighting system in Cut Bank.

Mont., Superior—City plans electric-light plant.

Neb., Bridgeport—Bridgeport Electric Light and Power Co. plans to improve and enlarge power plant.

N. C., Morehead City—City issued $20,000 bonds for electric-light improvements. M. L. Willis, Secy. and Treas.

N. C., Vancouver—Hotel Vancouver plans power plant.

N. D., Hurdsfield — Hurdsfield Milling Co. plans electric-light plant.

N. D., Minto—F. J. Lizkowski granted franchise to construct electric-light plant.

N. J., Blackwood—Camden County Almshouse plans new power house. Address County Clk., Camden.

N. Y., Buffalo—Delaware, Lackawanna & Western R.R., 24 Michigan St., soon to receive bids for power house. About $18,000. G. J. Ray, Engr.

N. Y., Hudson—(Official)—New York State Training School for Girls receiving bids Sept. 26 for heating work. A. Windsor Allen, Pres., Bd. Mgrs.

N. Y., Lockport—Hydraulic Race Co. plans extensive power developments at Lockport.

Ohio, Cincinnati—Springer & Wood Co., St. Louis, Mo., plans power plant at Walnut Hills.

Ohio, Cleveland—City votes in fall on $1,750,000 bonds for electric-light improvements. R. Hoffman, City Engr.

Ohio, Kenton—Hardin-Wyandoft Lighting Co. plans boiler house at Water St. plant.

Ohio, London—City soon to receive bids for electric-light plant. F. H. Froehlich, Second National Bank Bldg., Toledo, Engr.

Ohio, Rittman—City receiving bids Nov. 1 for power line from power station to pumping station. V. Hickin, Clerk.

Ohio, Wooster—Wooster Electric Co. plans to extend transmission lines about 8 mi.

Okla., Tulsa—Hickory Coal Co. plans power house. H. Adamson, mine foreman.

Okla., Waynoka—City plans to improve electric-light plant. About $25,000. W. R. Barrick, Pres., Bd. Trustees.

Ont., Arthur—Town plans hydro-electric system. About $15,000.

Penn., Halifax—Borough Council plans electric-lighting system.

Penn., St. Clair—Schuylville Railway Co. plans new power plant at St. Clair.

R. I., Cumberland—Blackstone Valley Gas and Electric Co., Pawtucket, granted permission for transmission lines on Wrentham, Sneach Pond and Sheldonville Rd.

R. I., Providence—Wanskuck Co., 725 Branch Ave., Providence, granted permit for addition to power plant of Mill No. 5.

S. C., Central—Citizens voted $10,000 bonds for electric-lighting system.

Wis., Kenosha—Wisconsin Gas and Electric Co. plans to spend about $250,000 for improving plant.